GASTRIC CANCER

by ALFRED H IASON, M D

Attending Surgeon Adelphi Hospital Director of Surgery Brooklyn Hospital for the Aged Surgeon Manhat[illegible]an General Hospital Instructor in Anatomy New York Medical College and Flower Hospital

Illustrations by
ALFRED FEINBERG

Instructor of Medical Illustration Department of Pathology College of Physicians and Surgeons Columbia University New [illegible]k City

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Introduction

In writing this book my endeavor has been to summarize succinctly for the undergraduate student the practicing physician and the surgeon the cumulative literature concerning gastric cancer and to crystallize my experience in that field In view of the monumental literature and current intensive investigations concerning the subject in question it is manifest that great condensation is necessary, as in my numerical method of describing operations for the alleviation of gastric cancer

It is a commonplace that the surgical literature is continually being enriched by new, and apparently basic clinical and experimental data concerning anesthesia, the use of antibiotics and the extension of standard surgical procedures to accomplish for example wider *en bloc* excisions of tumors however, many hypotheses are found transiently acceptable and constantly shifting until they become popular in the surgical world

Some of the new trends in cancer surgery and research concern prophylaxis, the controversial total gastrectomy *in vivo* combinations between carcinogens and tissue constituents and their possible or probable role in carcinogenesis effects of the application of carcinogens on exposed gastric mucosa in rats experimental cancer chemotherapy programs further studies in cytology and the histogenesis of gastric cancer new technics for the intra arterial administration of chemotherapeutic agents, such as nitrogen mustard evaluation of serologic reactions in diagnosis and staging of cancer study of known carcinogenic agents such as the application of carbon dioxide snow implanted cellophane ionizing radiations (metallic nickel salts of zinc and beryllium)

Despite universal brilliant research cancer and especially the gastric form is still—to use a Churchillian phrase— a riddle wrapped in mystery inside an enigma Truly it is a surgical Gordian knot yet to be unraveled It is of course, unpredictable from which source the next basic discoveries applicable to gastric cancer will come—perhaps they will be along the milestones erected by Francis Donaldson Beale, Dudgeon Wrigley Bamforth Papanicolaou Fleming Landsteiner Roentgen Domagk the Curies and a host of others Perhaps the enigma will be solved in further studies of human heredity cell growth and regeneration and of the dire pressures which shape human living habits

Today cancer mortality in the United States is over 250 000 a year It is apparently increasing at the rate of three per cent partly because of the greater number of persons living into the older age groups

It is hoped that this volume will prove of some use in intensifying the awareness of the reader regarding early prevention so far as possible and early detection of gastric cancer

A glance at the table of contents will of course indicate the range of the subjects treated herein The bibliography is limited to important original articles and to

CHAPTER I

Anatomy

The Stomach

Historical Notes Most of the characteristics of the anatomy and motility of the stomach were known to anatomists and physiologists for the last three centuries

The first anatomist to devote special attention to the stomach was Willis (1682) He introduced the term antrum to a part of the transverse stomach used the term fundus in the same sense as earlier anatomists for the area along the greater curvature and described the oblique fibers

Helvetius (1719) gave a clear description of the gastric muscular structure

Sommering (1844) described the external shape of the stomach This description was closely paralleled in later years by Luschka (1863)

Cruveilhier (1843) also noted the external shape of the stomach and partly its muscular structure According to this anatomist[1]

> The human stomach presents innumerable varieties from the stage of extreme contraction in which stage it does not surpass the volume of the duodenum which follows the stomach to the stage of the enormous dilatation when it fills up almost the entire abdominal cavity

Cuvier (1810) and Owen (1866) merely described the external contour of the stomach and its great variations in vertebrates

Otto V Aufschnaiter (1894) gave a remarkable account of the muscular structure of the human stomach

The first report of the roentgen cinematographic investigations of the stomach by Kastle Rieder and Rosenthal appeared in 1910

Congenital Malformations Some of the congenital malformations of the stomach are (1) congenital ab ence of the cardia (2) congenital defects in gastric musculature (3) congenital double septum (4) aberrant nodule of pancreatic tissue in the stomach wall (5) unusual variety of inversion (6) hypertrophic pyloric stenosis (7) congenital hour glass stomach (8) congenital peptic ulcer (9) congenital adhesive bands

Surface Anatomy Owing to the mobility of the stomach and its multiform variations and positions it is manifestly impossible to describe surface markings which are definitive of the outlines of normal stomachs

The body of the stomach extends from a horizontal plane through the cardiac opening to a cross section of the stomach through the incisura angularis in a vertical saggital plane

The body of the stomach lies anterior to the left suprarenal and kidney separated from this by the tail of the pancreas with the splenic artery along its upper border The lower two-thirds of the spleen is lateral and posterior the splenic flexure of the colon to its lateral side

When a person stands, breathing quietly, the esophageal aperture is usually found about opposite the tip of the eighth costal cartilage behind the left costal margin

The fundus may be shown by a semicircle convexly upward passing to the left of the esophageal aperture with a diameter of 3 to 4 inches Its upper limit is at the level of the fifth or sixth costal cartilage

The level of the fundus is little affected by change from standing to recumbency

The position of the greater curvature obviously depends on the state of digestion and the position of the body (It can be accurately ascertained by auscultatory percussion) The line of the greater curvature crosses the costal margin near the tip of the tenth costal cartilage and extends down to the level 1 to 2 inches below the supracristal plane or a little below it especially in slender persons

The lesser curve of the stomach can be delimited on the surface by a curved line drawn from a point on the seventh left costal cartilage 1 or ½ inch from the median line of the sternum to a point 1 inch to the right of the median line on the transpyloric plane

The angular notch of the lesser curvature is usually 1 inch or more above the supracristal plane and a little to the left of the middle line

The pylorus is usually situated about 1 inch to the right of the middle line and about 2 inches below and medial to the middle of the right costal margin In the recumbent position the pylorus commonly lies a little below and medial to the tip of the ninth costal cartilage and the lower part of the greater curvature is situated at or above the level of the supracristal plane, both being some 2 inches higher than in the standing person

Beyond the incisura angularis is the pyloric antrum which is pyriform, the narrow part of the pear being the pyloric canal

The pyloric antrum curves around the prominence of the vertebral column to end in the pyloric canal which is about 1¼ inches long and has a thicker muscle than the antrum proper

In stocky persons the stomach commonly remains at a higher level than the average caused by the greater breadth and depth of the abdomen As a rule it is more obliquely placed so that the fundus and pyloric canal are both on a plane posterior to that of the junction of the body with the pyloric antrum

Surgical Anatomy Cunningham states[2]

> No Anglo Saxon name for the human stomach has survived *Ventriculus* was a Latin name for it but it meant also the belly Stomach was only one of the meanings of the Greek word *gaster* from which we have gastric
>
> The word stomach has now a fixed and limited meaning in the strict English but it is the shortened form of the Greek word stomacho which originally meant the same as stoma (the mouth) was used as a designation for both the throat and the gullet and only later came to be applied to the part of the digestive tube that we now call stomach

It must to begin with be kept in mind that the shape of the abdominal cavity largely determines the position of the viscera A thorax of small circumference for example indicates smallness of the upper part of the abdomen with consequent downward displacement of the contents

In the horizontal stomach (as in infancy) the retort contour is the rule It appears

to be common until 3 years of age[3] In older children and in adults the predominant vertical position is accompanied by a more tubular form with a fish hook at the lower pole

As the stomach is dilatable and a movable organ its surface and abdominal rela tions vary

Position and Contour At birth the stomach occupies an oblique position approach ing the vertical one of its earlier stages of development After the fourth month it changes to a horizontal position which is characteristic of the adult

The stomach is obliquely situated so that its upper part is mainly to the left of the middle line above the level of the umbilicus The lower part is in contact with the anterior abdominal wall while the upper part lies in the hypochondrium within the concavity of the left dome of the diaphragm separated from the chest wall by the diaphragm and lower parts of the pleura and lungs (fig 1)

Because the stomach lies in an oblique plane directed downwards and forwards the lowest parts are the most anterior

The stomach is partly to the left of the liver and partly below the liver which overlaps it also anteriorly and a large part of it is under the protection of the ribs on the left side

The stomach in particular varies in position with posture contents and tonicity of the musculature It is however fairly well anchored by the gastrohepatic, gastro-splenic and indirectly by the hepatoduodenal ligaments The cardia is at the level corresponding posteriorly to the eleventh thoracic vertebra and anteriorly to the seventh chondrosternal junction and is about 1 inch left of the midline When the pylorus is empty it is at the level corresponding posteriorly to the first lumbar verte bra and anteriorly midway between the xiphoid cartilage and the umbilicus

In a manner of speaking the stomach can be termed a fluid organ It is displace able across the abdomen by a collection of gas in the colon It is easily moved upward for instance by pelvic tumors or pressure in the abdomen and even if greatly dis-placed it may not give signs of distortion or change of position

Healthy persons show a wide range in form and position of the viscera and athletes and very thin people seem prone to drop them all into the pelvis

The results of vagal stimulation for example differ widely when the tonus of stomach muscle is high or low Roentgenologists have stressed the fact that not only the tone of the stomach as a whole may vary but that the tone of part of the stomach may change This appears to occur mainly in relation to the greater curvature which may ascend and descend with great rapidity It has been noted that emotion lowers the tone of the greater curvature Tone must be partly dependent on the intrinsic neuromuscular constitution of the stomach wall (Auerbach s plexus longitudinal circular and oblique muscle fibers) for after removal of all the extrinsic nerves the stomach after a time functions normally

The only permanent effect that apparently follows denervation of the organ is a delay in the initial emptying time

The Normal Empty Stomach (Standing Person) The cardiac end of the stomach obviously varies in size according to the quantity of air contained in it

The shape and position of the stomach exhibit manifold variations depending upon the interaction of such factors as the degree of its distension the tone of its

musculature the age, sex and bodily build of its possessor and the activity of the abdominal musculature at the moment, concomitant modifications in shape and position are to be expected



Fig 1 —Note hape of stomach and normal variations demon trated by x ray (Courtesy The Ciba Collection of Medical Illustrations)

The variations of shape and position are of two kinds (1) Permanent differences—especially in the level and direction of the pyloric part— which seem to depend on body build or habitus (2) temporary alterations which are influenced by the degree of its distension and also by the position of the body as a whole

In the supine position the lower part of the emptied stomach is usually found more or less horizontal however its form and the level of the pylorus vary even in this position

In the erect posture the pyloric part descends the body of the stomach becomes more vertical and in all but a few people the whole organ (even if empty) then presents the characteristic J shaped outline which is seen in many persons even in the supine position If the stomach is now filled it elongates as well as widens, and to accommodate its increased length between its relatively fixed ends it descends almost vertically beyond the level of the umbilicus even into the pelvis and then bends upwards and to the right to reach the duodenum The axis of a normal full stomach is therefore J shaped

The cardiac orifice as a rule is about 1 inch to the left of the median plane about 4 inches behind the seventh costal cartilage, and at the level of the tip of the ninth thoracic spine The part of the stomach immediately adjoining it is related posteriorly to the posterior aspect of the diaphragm and anterior to the posterior aspect of the left lobe of the liver

The fundus rises to a point a little below the level of the left nipple—opposite the fifth rib It is closely related to the diaphragm which separates it from the pericardium and the heart

The pylorus when the stomach is empty or only partly filled is as previously stated about 1 inch to the right of the median plane opposite the first lumbar vertebra Anteriorly it is related to the quadrate lobe of the liver which conceals it the prepyloric vein lies between its muscular wall and peritoneal coat Posteriorly it is related to the neck of the pancreas separated by the lesser peritoneal sac

(The pylorus may lie anywhere along the lumbar vertebrae and has an excursion of 4 inches in all coronal directions)

The lesser curvature gives attachment to the lesser omentum and is related to the right and left gastric vessels between its layers

The greater curvature gives attachment to the gastrophrenic and gastrosplenic ligaments and to the anterior two layers of the greater omentum its lower part is related to the right and left gastricepiploic vessels between these layers

The anterior surface of the stomach is closely related to only three structures—liver diaphragm and anterior abdominal wall The part under the ribs is related in the main to the diaphragm however near the cardiac orifice it is separated from the diaphragm by the liver Beyond the diaphragm it is overlapped by the left lung and to a greater extent by the left pleura The part not covered by the ribs is overlapped in its upper part by the left lobe of the liver while its lower part is related to the sheath of the left rectus abdominis

The posterior surface is related to a number of structures in the stomach bed These structures are situated as follows (1) The body of the pancreas lies obliquely across the back wall behind the stomach (2) the splenic artery runs along the upper border of the pancreas (3) a small part of the left kidney is exposed above the pancreas (4) the left suprarenal gland overlaps the medial part of the upper end of the kidney (5) the spleen is lateral to those four structures (6) the diaphragm with branches of phrenic vessels is above all these behind the uppermost part of the

stomach, (7) the transverse mesocolon stretches down from the pancreas behind the lower part of the stomach, and the transverse colon itself may be partly behind the stomach

The aforesaid structures are separated from the stomach by the cavity of the lesser peritoneal sac, and the spleen is also separated by the gastrosplenic ligament

Dimensions of the Stomach The stomach is about 12 inches long by 4 inches in average dimensions

Parts of the Stomach E Muller (1897) was perhaps the first anatomist who attempted to improve the terminology relating to the stomach by suggesting the abolishment of the term "antrum" In his day the term was used in two senses—on the side of the antrum of Retzius (which included the entire transverse stomach) and on the other side of the antrum of Luschka which comprised a small area close

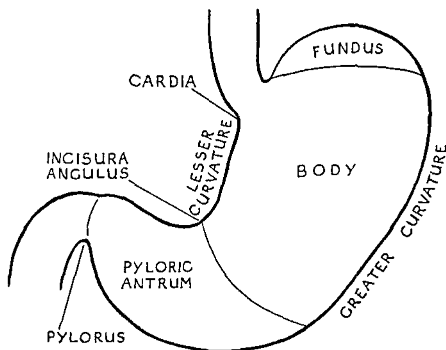


Fig 2 —Anatomic division of stomach into component parts

to the pylorus This dual meaning of the term antrum is subsequently also found in the two senses of sphincter antri'

As a rule the stomach is described as being divided into three parts (a) the upper part (pars cardiaca) is referred to as the fundus and lies above a hypothetic line drawn from the lateral border of the esophagus to the greater curvature at the juncture of the medial border of the esophagus and pars cardiaca the incisura cardiaca is formed by the curving upward of the stomach this part is the fornix and site of the usual gas bubble (b) the right border of the stomach lesser curvature forms an angle by curving to the right the incisura angularis is thus formed a hypothetic line drawn from the incisura to the greater curvature forms the upper subdivision pars media and lower part (c) pars pylorica which terminates at the junction between the stomach and duodenum pars media and pylorica are respectively referred to as the body and antrum of the stomach (fig 2)

The part of the stomach occupying the left hypochondriac region is the cardiac end of the stomach three fourths of the organ lying in that area The part in the epigastric area is the pyloric end

The junction of the esophagus and stomach is not at the extreme end of the stomach but some distance below at the upper end of the lesser curvature The right margin of the esophagus merges almost imperceptibly with the lesser curvature, while the left margin forms a deep notch for the fundus

Fixation of the Stomach The stomach is held in position superiorly by its continuity with the esophagus and below by its continuity with the duodenum The stomach is also supported by the gastrophrenic ligament which connects with the diaphragm the gastrohepatic or lesser omentum and the gastrosplenic omentum, which connects the cardiac end of the stomach with the hilum of the spleen

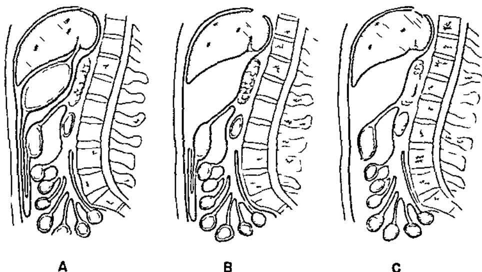


Fig 3—A. Lateral view of delineation of visceral peritoneum B Same after removal of stomach gastrohepatic and gastrocolic omenta C Same after removal of great omentum

The fixed part of the stomach is the lesser curvature, when the stomach is distended it consequently rotates upon its fixed axis the lesser curvature the anterior surface is turned upward the posterior downward and the greater curvature is carried forward against the anterior abdominal wall

(It is well to keep in mind that the viscera are maintained in position by the action of the muscular abdominal walls by peritoneal attachments and by vascular pedicles, but the most important are the muscles—external and internal oblique transversalis rectus abdominis diaphragm and levator ani By their contraction or tonus they keep the viscera pressed together in the upright posture and the weight of the upper viscera rests on the lower ones On rising from the supine to the upright position the upper viscera and diaphragm descend about one half inch or more [fig 3])

Mobility The stomach may be said to be functionally divided into two parts The cardiac part to the left of the incisura angularis (fundus and body) has relatively less mobility than the pyloric part The latter (pyloric antrum and canal) is much more

motile The first part of the duodenum is functionally integrated with this part of the stomach

The mobility of the stomach makes it easily displaceable by various abnormal conditions in related organs

Cardiac End The range of movement shown by the cardiac end is consequent upon the ascent and descent of the diaphragm to which it is connected It has no independent movement (fig 2)

Pyloric End This part of the stomach is continuous with the beginning of the duodenum Together they have a definite movement

When food enters the stomach enlarges and rotates around an axis which passes through the esophageal opening and the pylorus The stomach then takes up a more or less transverse position with the lesser curve directed upwards and to the right and the greater curve downwards and to the left

TABLE 1 —*Approximate Volume of the Stomach*

Age	Ounces	Cubic Centimeters
Birth	1 2	36
1 month	2 0	60
2 months	3 37	100
3 months	4 50	132
4 months	5 00	150
5-6 months	5 75	172
7-8 month	6 88	200
10-11 months	8 14	244
12-14 months	8 90	265
2 years	11 80	350
3 years	16 85	500
4 year	20 22	600
10 years	25-27 40	750-800

Some of the salient facts to keep in mind in relation to normal stomachic movement are the following in the fasting stomach there are brief rhythmic increases of tone (about every 20 seconds) The contractions are confined to the fundus After the taking of food peristaltic waves occur (about every 20 seconds) moving toward the duodenum The emptying of the stomach is unaffected by gravity Stimulation of the afferent nerves from any abdominal viscera (gallbladder appendix for example) sometimes causes reflex contraction of the pylorus and disturbances of stomach tone and motility in general

The stomach in its entirety possesses tone—in other words its wall is constantly in a state of incomplete contraction irrespective of peristaltic activity This tonus is controlled by the intrinsic nervous plexus in the wall of the organ and is independent of extrinsic nervous supply

In the adult the average capacity is 5 pints (2½ liters) though it may hold 4 liters In gastrectasis the capacity may of course be greatly increased

Gastric Arteries The arterial supply to the greater curvature of the stomach and the corresponding veins lie between the lamellae of the greater omentum similarly those to the lesser curvature are situated between the layers of the lesser omentum

The blood vessels along the great and lesser curvature are situated a short distance away from these borders those along the greater curvature are farther away than

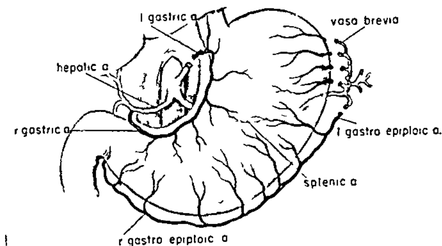


Fig 4 —Blood supply of stomach



Fig 5 —Blood vessels A Right gastric B Left gastric C Right gastroepiploic D Left gastroepiploic E Inferior pancreaticoduodenal F Duodenum G Hepatic artery H Celiac axis I Vasa brevia

those of the lesser curvature These positions permit distension of the stomach without affecting the circulation (figs 4 5)

All arteries of the stomach ultimately stem from the celiac axis The fornix and

the corpus receive their blood supply from the *left gastric artery, vasa brevia* and left gastroepiploic artery. The pyloric part is supplied by the right gastric artery and the right gastroepiploic artery.

In surgery of the stomach it is well to keep the following *anatomic facts in mind*.

The vessels *run in* the stomach wall almost at right angles to the long axis and an incision into the living stomach is made parallel to the vessels.

Multiple anastomoses are present between branches of the left gastric artery and (a) esophageal arteries, (b) phrenic arteries, (c) right gastric artery, (d) vasa brevia, and there are (e) anastomoses between branches of the hepatic and phrenic arteries.

The submucous arterial plexus (from which the gastric mucosa derives its blood supply) surrounds almost the whole stomach. *From the plexus small arteries arise with extremely few anastomoses between them. They are, in effect, end arteries* (fig. 5).

Owing to the presence of many anastomoses between the gastric and esophageal and phrenic arteries (as well as to the presence of an arterial net surrounding the stomach) the arterial blood circulation in the organ is not greatly interfered with by the ligation of its main arteries.

After ligation the remaining arteries are greatly enlarged. New anastomoses form through the adhering liver, spleen, kidney, pancreas or *intestine. No permanent damage to the secretory or the motor function of the stomach results after almost complete dearterialization of the organ.* In examples of profuse gastric hemorrhage it is permissible to tie one or two arteries nearest to the point of bleeding, however, tying the gastric arteries and the gastric veins is a dangerous step because it causes gangrene of the stomach (figs. 6, 7).

Resumé

Arteries	*Source*
Coronary (left gastric)	Celiac axis
Pyloric (right gastric)	Hepatic (branch of celiac axis)
Gastroepiploica dextra	Gastroduodenal (branch of hepatic)
Gastroepiploica sinistra	Splenic (branch of celiac axis)
Vasa *brevia*	Splenic (branch of celiac axis)

Gastric Veins. The veins of the stomach correspond to the arteries.

Veins	*Empties into*
Coronary (left gastric)	Portal vein
Pyloric (right gastric)	Portal vein
Gastroepiploica dextra	Superior mesenteric vein
Gastroepiploica sinistra	Splenic vein
Vasa brevia	Splenic vein
Superior vein of Mayo	Pyloric vein
Inferior vein of Mayo	Gastroepiploica dextra

Nerves. The stomach is innervated by both the sympathetic and parasympathetic systems. The parasympathetic supply is derived from the right and left vagus nerves. The esophageal plexus formed by the vagus nerves envelopes the esophagus but at the diaphragm emerges as single nerves anteriorly and posteriorly, passing through the esophageal orifice of the diaphragm to reach the respective surfaces of the stomach. These are denominated the anterior and posterior gastric nerves and they follow

the lesser curvature to some extent sending branches to the stomach wall The posterior nerve also communicates with the celiac plexus while the anterior nerve sends branches through the lesser omentum to the hepatic plexus The sympathetic

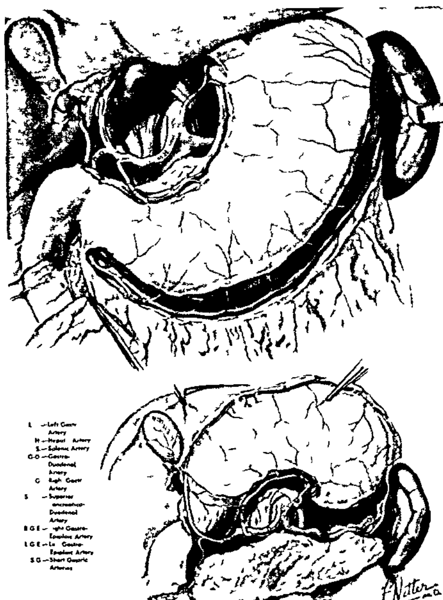


Fig 6 —Arterial supply of stomach derived from celiac artery (Courtesy The Ciba Collection of Medical Illustrations)

supply of the stomach is derived from the celiac plexus which is made up of fibers which reach it from the greater splanchnic nerve and the lesser splanchnic nerve on each side (fig 8)

The vagus may be regarded as the nerve which augments all movements of the stomach relaxes all sphincters and stimulates all secretions (see figs 8 12)

(The main component of the vagus—wanderer—is the great motor and sensory supply to cervical, thoracic and abdominal viscera—from the epiglottis to the end of the transverse colon.)

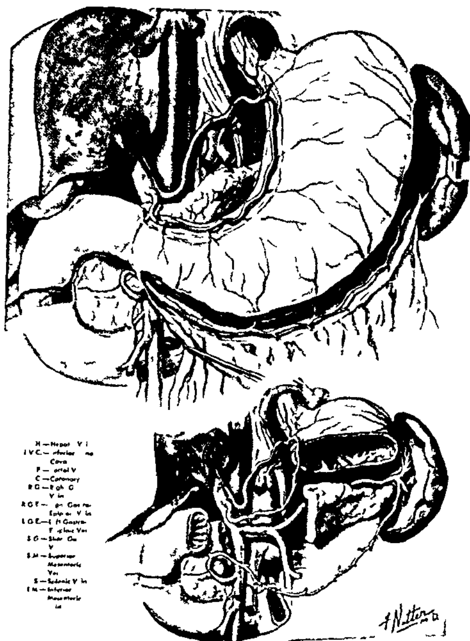


Fig 7 – Venous drainage of stomach emptying into portal vein (Courtesy The Ciba Collection of Medical Illustrations.)

The splanchnic nerves through the celiac plexus form the course by which the sympathetic fibers traveling along the blood vessels reach all parts of the stomach including the lowest part of the esophagus. The effect of stimulating the sympathetic fibers is precisely the opposite to that obtained from the vagus.

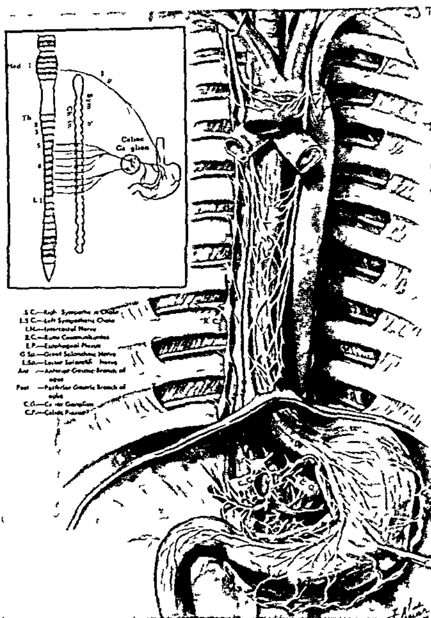


Fig 8 —Nerve supply of stomach showing innervation by the sympathetic system through the celiac ganglion and by the parasympathetic through vagus. (Courtesy The Ciba Collection of Medical Illustrations)

This regulatory influence is exerted not directly upon the muscle or gland but by the intermediation of chemical substances Thus acetylcholine is released by vagal stimulation and inhibitory adrenalin like substance by the sympathetic stimulation

Lymphatics of the Stomach The lymphatic drainage of the stomach takes place through the celiac system of lymph nodes This group is sometimes denominated the celiac glands and lymph from them is collected in the cisterna chyli by the gastrointestinal lymph trunk (figs 9 10)

The stomach comprises three main lymphatic drainage areas, the principal drainage from each eventually reaching the middle suprapancreatic or celiac nodes, as indicated in figure 11

The lymphatics pass in different directions to the nearest lymph glands These glands lie alongside the vessels whose branches supply the stomach and they transmit the lymph to the lymphatic glands that lie on the posterior wall of the abdomen in relation to the pancreas

The lymphatic drainage corresponds closely to the distribution of the blood vessels The vessels drain into the lymph nodes arranged in four main groups, namely (a) coronary, (b) celiac, (c) right gastroepiploic and (d) subpyloric



Fig 9 —Lymphatics of stomach

(a) *The Coronary Nodes* These are found along the lesser curvature in two subgroups upper and lower

The lower group lies contiguous to the lesser curve and the nodes which form it increase in size as they approach the esophageal end The upper group rest more around the main stem of the left gastric artery just as it detours to pass between the two layers of the lesser omentum

(b) *The Celiac Nodes* These are arranged along the upper border of the pancreas in three subgroups The middle nodes are situated around the celiac axis the right lateral along the hepatic branch and the left lateral along the splenic branch

(c) *The Gastroepiploic Nodes* These are present below the right gastroepiploic artery and drain into the subpyloric group

(d) *The Subpyloric Group* These are in close relation with the head of the pancreas

in the angle between the first and second parts of the duodenum They are easily involved in malignant diseases of the pyloric end of the stomach

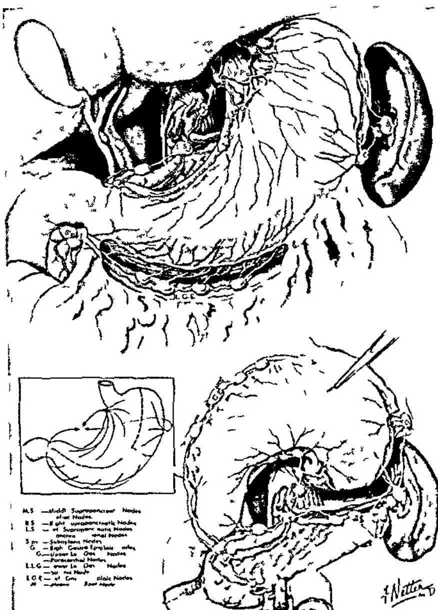


Fig 10 —Lymphatic drainage of stomach through celiac system of lymph nodes to cisterna chyli by gastrointestinal lymph trunk Note connection with mesenteric root nodes (Courtesy The Ciba Collection of Medical Illustrations)

It is obvious then that an incision from the right side of the esophageal end of the lesser curve to the junction of the right and middle thirds of the greater curve will

have most of the lymph nodes on the right and it is this part which is removed in incomplete gastrectomy Owing to an extension of infection or other involvement

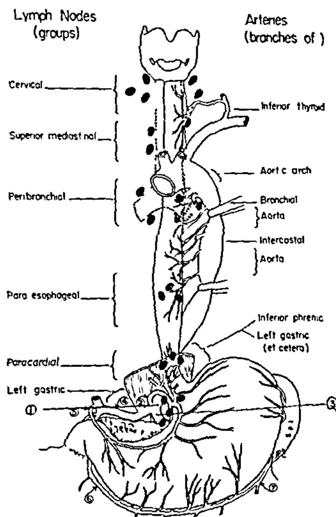


Fig 11 —Lymph nodes and arteries of the esophagus The important groups of lymph nodes which drain the esophagus at various level are shown on the right side On the left are illustrated the principal arteries which supply the esophagus Several small arteries which contribute to the blood supply of the abdominal segment including the branch from the superior suprarenal artery lie posteriorly and are not shown The arteries which have to do with the blood supply of the stomach are designated by number as follows 1) celiac axis 2) left gastric artery 3) splenic artery 4) hepatic artery 5) right gastric artery 6) right gastric epiploic artery and 7) left gastro-epiploic artery The vasa brevia pass between the hilus of the spleen and the fundus of the stomach (Courtesy Sweet R H *Thoracic Surgery* Philadelphia Saunders 1950)

along lymphatic vessels of the esophagus enlarged lymph nodes are sometimes found in the left supraclavicular fossa (see figs 9-11)

The pylorus proper drains both upward to the suprapyloric nodes and downward to the subpyloric nodes along the gastroduodenal artery, anterior to the pancreas

to the superior pancreatic nodes and downward anterior to the pancreas to nodes lying adjacent to the superior mesenteric artery

Carcinoma of the pylorus usually spreads towards the cardiac end of the stomach particularly along the lesser curvature, therefore the whole lesser curvature and all suspected lymph nodes should be removed (*In removing the nodes from the greater omentum there is danger of wounding the middle colic artery*) Gangrene of the transverse colon may result This is of basic importance in the surgery of the stomach

It must be kept in mind that the celiac axis is retroperitoneal and that the coronary artery in its course along the lesser curvature of the stomach lies in the gastrohepatic omentum but that that part of the coronary artery before its inclusion in the lesser omentum lies in the falx coronaria or gastropancreatic fold of peritoneum Here a number of lymph nodes are to be found and the lymphatics from the nodes in the lesser omentum drain through these In the operation for cancer of the stomach the relation of the subpyloric lymph vessels to the superior mesenteric group of nodes the suprapyloric of the retroduodenal biliary group and the direct route of drainage from the pyloric area to the nodes on the falx coronaria is to be kept constantly in mind

The fundus of the stomach is drained by radicles which empty into the nodes along the splenic artery It is rare to find lymph nodes in the middle part of the greater curvature and exceptional to find them in the area of the fundus

The main set of glands most important to the surgeon because of their involvement in cancerous enlargement are the left gastric glands These are the largest of all the gastric groups and are to be found along the lesser curvature of the stomach in the area between the layers of the gastrohepatic omentum These glands drain the upper three quarters of the lesser curvature and sometimes the curve in its entirety The lower part is commonly drained by the glands surrounding the pylorus and secondary growths from a cancer in this upper area of the pyloric canal are likely to be near the upper border of the head of the pancreas and among the vessels bile ducts portal vein hepatic artery which form the anterior border to the aditus of the lesser curvature

The greater curvature of the stomach is drained by the lymphatic glands associated with the splenic artery and left gastroepiploic artery in its upper part the lower part of the body of the stomach and pyloric antrum being drained by the (right) gastroepiploic lymph glands and the pyloric canal drains into the anterior group of pyloric glands in or on the head of the pancreas directly below the pylorus

There are two or three small glands near the cardiac orifice which drain a small area of the stomach in that situation Their channels communicate freely with the left gastric lymphatic system and this latter group of glands is involved early when cancer affects the cardiac area

If cancer cells pass along the efferent of the celiac lymph glands and enter the thoracic duct they may subsequently involve the left lower anterior group of the deep cervical lymph glands which are sometimes found enlarged in malignancy of the stomach (Troisier s sign) From the thoracic duct the cells may pass into the left innominate vein and so be deposited in any part of the body

The Peritoneum

The peritoneum is the largest serous membrane in the body It has been estimated to equal in area approximately the total cutaneous surface of the body

In the male it is a closed sac but in women the free extremities of the uterine tubes open into the peritoneal cavity

In the upper part of the abdomen the peritoneum is attached to the under surface of the diaphragm so far backwards as the posterior surface of the liver and the cardiac orifice of the stomach It is then reflected forwards on the upper surface of the liver forming the ligaments of that organ

The stomach except for a small surface below and to the left of the cardia, is completely covered by peritoneum

The Peritoneal Cavity The peritoneal cavity is the area enclosed by the peritoneum It is divided into the greater peritoneal cavity (great sac) and the lesser peritoneal cavity (omental bursa) These communicate with each other to form a narrow channel—the foramen of Winslow (epiploic foramen)

None of the abdominal viscera is in the peritoneal cavity, because *the peritoneum* is reflected over or partly around the organs

Peritoneal Reflections The peritoneum forms as previously stated, a complete or incomplete covering for nearly all the abdominal viscera In certain situations it is reflected from one organ to another and from the organs to anchorages on the walls of the abdomen Folds are thereby formed which receive specific names *according to* their situation such as the mesentery omentum, mesocolon and certain ligaments

When the peritoneum is traced vertically a convenient area from which to begin is the transverse fissure of the liver With the organ drawn out of the way—upward and laterally and the stomach drawn downward and to the left—a double fold is seen the gastrohepatic or lesser omentum which descends *to the lesser curvature of* the stomach and is stretched between these two organs (fig 3)

The two layers separate on reaching the stomach to enclose that organ one layer passing anteriorly to it and the other posteriorly At the greater curvature *they* again meet and pass, apron like downward to the lower part of the abdomen forming the two anterior layers of the greater omentum They *then coil themselves and ascend to the transverse colon, this last reflection* constitutes the two posterior layers of the greater omentum They again separate and inclose this part of the colon one layer passing above and one beneath it

Along the posterior surface of the transverse colon these two layers again meet *to form the transverse mesocolon which passes to the posterior* wall of the abdominal cavity Opposite the lower border of the pancreas they divide into an ascending and a descending layer The ascending layer courses anterior to the pancreas the second part of the duodenum the crura of the diaphragm and then to the nether *surface of* the diaphragm It is thence reflected to the posterior surface of the liver forming the inferior layer of its coronary and lateral (triangular) ligaments and then to the under surface of the liver so far as the transverse fissure the area of starting the outlining Here it is continuous with the posterior layer of the lesser or gastrohepatic omentum

The descending layer of the transverse mesocolon passes over the third part of

the duodenum the posterior abdominal wall and the superior mesenteric vessels to to the jejunum and ileum The e two intestinal components are surrounded and the course now is back again to the posterior part of the abdominal cavity to form the mesentery From here it ascends to pass anterior to the aorta and inferior vena cava into the pelvis

Peritoneal Connections of the Stomach (1) The gastrocolic ligament connects the greater curvature of the stomach with the transverse colon It continues as pre viously stated downward as the two anterior layers of the great omentum In it are contained the right and left gastro-epiploic vessels

(2) The lesser or gastrohepatic omentum is superiorly anchored to the portal fissure of the liver and partly to the diaphragm The right free border of the lesser omentum forms the anterior boundary of the foramen of Winslow It contains in its thick part (hepatoduodenal ligament) the common bile duct the portal vein and the hepatic artery In the gastric attachment of this omentum are the pyloric (right gastric) and left coronary (left gastric) arteries

(3) The gastrophrenic ligament passes backward from the cardiac end of the greater curvature to the diaphragm It is joined on the posterior abdominal wall by a peritoneal fold—the gastropancreatic ligament This structure carries the coronary (left gastric) artery to the cardiac end of the lesser curvature

(4) The gastro-splenic omentum extends from the greater curvature in the area of the fundus to the hilum of the spleen It contains the left gastro-epiploic artery and the vasa brevia of the splenic artery

Omenta The omenta are three folds of peritoneum which connect (a) the stomach to adjacent viscera (b) the stomach to the transverse colon (greater omentum) (c) the stomach to the liver (lesser omentum), (d) the stomach to the spleen (gastro-splenic)

The Greater Omentum This structure is suspended from the greater curvature of the stomach and the free border of the transverse colon It covers the small intestine, as a rule so far as the pelvis Between the two layers of this omentum is a large part of the lesser peritoneal cavity (omental bursa) and along the greater curvature of the stomach is the arterial loop formed by the anastomosis between the right and left gastroepiploic arteries

The Lesser Omentum The lesser omentum passes between the liver and stomach In its lower part its dual layers become respectively continuous to form a free margin and superiorly they are affixed to the margins of the porta hepatis This omentum does not provide support for the stomach It is attached below and on the left to the first inch of the duodenum and as previously stated to the lesser curvature of the stomach Above it is anchored to the diaphragm directly to the right and above the esophagus superiorly and on the right to the fissural floor for the ligamentum venosum and to the margins of the porta hepatis

The two leaves of this omentum enclose (a) extra peritoneal tissue (b) fat (more or less) (c) right and left gastric vessels in the lesser curvature with branches to the stomach (d) portal vein bile duct and hepatic artery (in the free edge) (e) sympathetic nerves (f) lymphatic glands accompanying the veins

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Mesentery The mesentery is the extensive fold by which the jejunum and ileum

are attached to and suspended from the posterior abdominal wall and contains between its layers the blood vessels of the intestine

The mesentery is attached posteriorly to the left side of the 2nd lumbar vertebra, passing downwards across the vertebrae to the right of the sacro-iliac joint It contains the superior mesenteric vessels jejunum and ileum between its layers The upper layer is continuous with the inferior layer of the transverse mesocolon and lower layer with the peritoneum on the posterior abdominal wall (fig 3)

The free border of the mesentery is so long as the intestine which it encloses—20 feet—but its greatest length is not obvious because the structure is thrown into undulating folds to accommodate itself to the coils of the intestine The parietal border is *called the root of the mesentery and it is only about six inches in length*

The parietal attachment of the mesentery is variable The area at which this attachment commences above is constant It corresponds with the end of the duodenum is about on a level with the lower border of the pancreas and is adjacent to the 2nd lumbar vertebra From here the insertion of the mesentery follows an oblique line that runs downwards and to the right crossing the great vessels and then ending in the right iliac fossa, opposite the right sacroiliac articulation The parietal attachment of the mesentery measures as a rule, about six inches From this oblique attachment it follows that when effusion takes place in the abdomen on the right side of the mesentery the fluid is first conducted into the right iliac fossa, when on the left side into the pelvis

The transverse mesocolon is formed by the junction of the two ascending layers of the greater omentum after they have enclosed the transverse colon at the spine the two layers separate into ascending and descending layers

The length of the mesentery from spine to bowel varies in different parts of the canal its average length is eight inches The longest part is that which goes to coils of intestine lying between an area six feet from the duodenum and an area eleven feet from the same part of the intestine

Peritoneal Spaces Owing to the arrangement of the peritoneum the cavity of the abdomen is divided into a number of potential spaces which are connected by certain definite communications or routes (fig 3)

The main spaces are

1 The lesser sac of the peritoneum (omental bursa) It forms a diverticulum which lies behind the greater sac above and partly within it below since it extends from the Spigelian lobe of the liver to the lowest part of the great omentum It communicates with the greater sac by means of the foramen of Winslow and extends transversely from this opening to the hilum of the spleen
2 The right subphrenic space between the diaphragm and the liver, it is bounded toward the midline by the falciform and coronary ligaments, below it opens into the subhepatic space
3 The left subphrenic space between the diaphragm above and left lobe of the liver and stomach below, it is separated from the corresponding right space by the falciform ligament
4 The pelvis

The Esophagus

Congenital Malformations The commonest variety of esophageal malformation—congenital atresia with tracheal fistulae—often has a fatal issue

Short Esophagus and Thoracic Stomach The association of congenital shortening of the esophagus with incomplete intrathoracic stomach has been reported for a great many years in surgical literature the world over

The stomach it must be recalled is primarily a thoracic organ and during embryologic development descends into the abdomen Following this there is a fusion of the diaphragm except for the esophageal hiatus If the stomach fails to descend normally the esophagus remains permanently shortened and a greater or less part of the stomach remains within the thorax The esophageal hiatus then is usually large and lax

Symptoms often appear in middle life There is delay in the passage of food at the junction of esophagus and fore stomach causing a low grade esophagitis with subsequent fibrosis and dysphagia This condition closely mimics carcinoma for there is loss of weight substernal discomfort or pain and at times blood stained vomitus

There are two varieties of short esophagus namely

1 Congenital
   (a) Usually discovered in children
   (b) Adult form usually found after forty years of age In this group there is a higher incidence among women than men

   In early examples the condition is commonly discoverable in children of the asthenic thin build while the late congenital forms are seen in the broad pyknic patient
2 Presumably acquired

Position of the Esophagus The esophagus a musculo membranous tube, is contained partly in the neck and abdomen but in the main in the thoracic cavity in the superior and posterior mediastina The tube begins behind the cricoid cartilage and passes posterior to the trachea in its upper half and in its lower half behind the pericardium Before perforating the fleshly part of the diaphragm behind its central tendon and immediately to the left of the median plane it turns forward and to the left

The abdominal esophagus is short and takes a course to the left and downward behind the esophageal notch of the liver and about two inches below the xiphoid process close to the left costal margin

The right margin of the esophagus passes into the lesser curvature while the left one is separated from the fundus by a notch

The esophagus lies between the two pleural sacs but in contiguity with the left above and the right below (Carcinoma of the esophagus is therefore said to extend to the right lung and pleura more often than to the left) The thoracic duct is to the right below to the left above and crosses behind it about the 4th or 5th thoracic vertebra Loose cellular tissues (continuous with that behind the pharynx) attaches the esophagus to the vertebrae

The loose structure of the submucosa allows a distinct dilation of the esophagus when food is swallowed At other times the lumen is almost completely obliterated by longitudinal folds which include the mucous membrane the muscularis mucosae and the submucosa

Finally there is the internal mucous coat

In the esophagus the elastic tissue is most abundant at the lower end The normal twist at this end helps to maintain the closure of the so called cardiac sphincter The pressure of the left crus of the diaphragm posteriorly and of the liver anteriorly aid in the same effect

Many years ago it was found that when the stomach is filled with a neutral solution it runs back and forth between the esophagus and stomach without hindrance When however, the solution is made acid it is shut off from the esophagus and retained in the stomach

Relations of the Esophagus The relations of the esophagus are particularly of importance at the narrow areas where lesions are likely to take root in the neck Here esophagotomy and other operations are carried out and injuries are likely to occur

The esophagus follows the curves of the cervical and dorsal spine till it passes anterior to and to the left of the aorta prior to penetration of the diaphragm In addition to the deviation to the left at the diaphragm it also shows a left lateral curvature at the root of the neck

Cervical Relations Anteriorly, with the trachea and thyroid gland, posteriorly, with the vertebral column the longus colli muscles laterally, with the common carotid artery, lobes of the thyroid gland, recurrent laryngeal nerve and thoracic duct

Thoracic Relations In the superior mediastinum the esophagus passes between the trachea and vertebral column behind and to the right of the aortic arch to the descending aorta and through the diaphragm Anteriorly are the trachea, left bronchus, pericardium and diaphragm Posteriorly, the vertebral column the longus colli muscles right aortic intercostal arteries thoracic duct hemiazygos veins and aorta

Left relations the superior mediastinum terminal part of aortic arch, left subclavian artery thoracic duct, left pleura recurrent nerve and descending thoracic aorta

Right relations right pleura and azygos vein and vagi

In the upper part of the thorax the esophagus is in close relation to the parietal pleura The arch of the aorta then courses between the two opposite the third and fourth thoracic vertebrae On the right side the vena azygos arches forward between the esophagus and the right parietal pleura

In the center of the thorax the esophagus returns to the midline and is equally in relation with the two pleurae In its lower part the esophagus is again contiguous to the left pleura

The aorta winds spirally around the esophagus, passing anteriorly above then to the left then posteriorly and finally posteriorly and to the right Below the aortic arch the esophagus is directly behind the bronchial glands and the pericardium (corresponding to the left auricle)

The vagi come into relation with the esophagus below the roots of the lungs the left nerve as it descends resting anteriorly the right posteriorly Each divides into a number of branches—on the right commonly three, on the left two, forming an

esophageal plexus of nerves which tends, however, to reunite into two trunks before piercing the diaphragm. Each trunk contains a proportion of fibers from both vagi.

Abdominal Relations. The esophagus passes through the muscular part of the diaphragm posterior to the central tendon. The right margin of the esophagus merges with the lesser curvature and the left margin is separated from the fundus by a notch.

The part of the gullet between the midriff and stomach (measuring about 1.25 cm. in length) rests on the posterior aspect of the left lobe of the liver and is close to the left phrenic artery. The gastric nerves pass through the diaphragm with the esophagus—one anteriorly and the other posteriorly.

Direction of the Esophagus. The direction of the esophagus, as previously stated, is not straight. It inclines to the left in the neck but is pressed back to the median line by the left end of the aortic arch opposite the fourth thoracic vertebra. Below this it again curves slightly to the left so that its diaphragmatic orifice is normally somewhat to the left of the median line and to the left and anterior to the aorta. In the sagittal plane it follows the curved line of the vertebra to the fourth thoracic vertebra, below this vertebra it gradually leaves the spinal column and passes more vertically to its diaphragmatic orifice.

Calibre of the Esophagus. The esophagus is the narrowest part of the gastrointestinal tract. When empty it is distinctly flattened anteroposteriorly above, its lumen being a frontally placed slit. In the whole thoracic part it is wide open during life.

The diameters of the esophagus increase on the average from above downwards. Annular constrictions, however, can usually be seen in three situations: behind the cricoid cartilage, behind the bifurcation of the trachea, and in the esophageal opening of the diaphragm. The uppermost is frequently the narrowest.

The lumen of the esophagus (except during the act of swallowing or vomiting) is always closed in the cervical part, sometimes closed and sometimes open in the thoracic area, depending on whether the stomach is full or empty of gas or fluid.

The lowest constriction is the narrowest, measuring 12 mm. in diameter as compared to 14 mm. for the upper two, but it is more distensible allowing of rapid dilatation to 22 mm., the other two to 18 or 19 millimeters.

Diverticula of the esophagus are frequently reported in medical literature. Thus a traction variety is induced by diseased lymph glands adjacent to the tube. Again the esophageal wall may fall over the margin of what is known as Leugart's pouch—a fibrous band which passes from the left bronchus to the lateral apsect of a vertebra.

Commonly the diverticula of the esophagus are pharyngeal pouches which extend downwards into the neck. The pouches commence on the posterior lateral wall of the pharynx directly above the junction with the esophagus. The pouch is situated posterior to, and usually to the left of, the esophagus. The sac may extend down the neck into the thorax.

Length of the Esophagus. The length of the esophagus at birth is about 10 cm. In an adult man it averages 25 cm., the distance from the sixth cervical vertebra, its upper end, to the tenth or eleventh thoracic vertebra.

The length of the cervical part, i.e., above the episternal notch or the second thoracic intervertebral disk, averages 5 to 7 cm. and ranges between 4½ and 8½ cm., varying with the length and position of the neck.

Level of the Esophagus The level of the commencement of the esophagus depends on the position of the head and neck and varies from the fifth to the sixth or seventh cervical vertebra In the position midway between flexion and extension of the neck its upper end (behind the lower border of the cricoid cartilage) is on a level with the 6th cervical vertebra Its lower end passes through the diaphragm, opposite the tenth thoracic vertebra to end in the stomach opposite the eleventh vertebra

Movements of the Esophagus There are three phases of peristaltic action in the esophagus termed primary secondary and tertiary Primary peristalsis is the contraction wave that follows a swallowing movement for about five or six seconds The rate at which the wave travels is more rapid in the upper part of the tube than in the lower

Secondary peristalsis does *not* follow a swallowing movement It is started by the presence of a bolus of food in the esophagus proper This movement takes place only if the primary wave leaves some part of the bolus behind It is a reflex action

Tertiary peristalsis is similar to the secondary except in the mechanism of the reflex In the lower one half or one third of the esophagus is the Meissner Auerbach plexus, described later This is a network of automatic nerves lying in the wall of the gastrointestinal tract It is present throughout the tract from the lower part of the esophagus downward

The chief swallowing center is situated in the medulla oblongata, adjacent to the nucleus of the vagus The efferent fibers travel to the various muscles taking part in the act by the hypoglossal, trigeminal (to the mylohyoid muscle in the floor of the mouth) and the glossopharyngeal and vagus nerves to the muscles of the pharynx and esophagus

Sphincters The lower circular part of the inferior constrictor muscle of the pharynx actually the cricopharyngeous sphincter is a thick ring of muscular fibers normally keeping the upper end of the esophagus tightly closed

The cardiac sphincter is such in a physiologic sense It has been demonstrated that a pressure from above of only 5 to 7 mm of water is sufficient to cause it to open whereas pressure from the cardiac side induces spasm and must rise to 50 mm of water in order to cause the sphincter to open (fig 12)

The mechanism of the closure of this sphincter is unknown In any case it appears that experimentally strong stimulation of sensory nerves of the abdominal viscera induces cardiospasm reflexly by way of the sympathetic afferent pathways

The cardiac sphincter receives inhibitory fibers from the vagus and excitatory fibers from the sympathetic Sometimes the innervation of the sphincter becomes disordered the sympathetics being overactive or the vagus underactive The muscles as a result remain conically contracted during swallowing and thus prevent the easy entrance of *food into the stomach Difficulty in swallowing is experienced* and the esophagus for some distance above the obstruction becomes distended by retained food This condition is called cardiospasm

Esophageal Coats The esophagus has four coats The external (fibrous) one consists of bundles of white tissue with many elastic fibers It serves to connect the esophagus with the surrounding structures

The second coat is the muscular one The third is the submucous or areolar coat

which is composed of loose fibrous elastic tissue It contains the larger blood vessels lymphatics and nerves as well as the irregularly distributed mucous glands

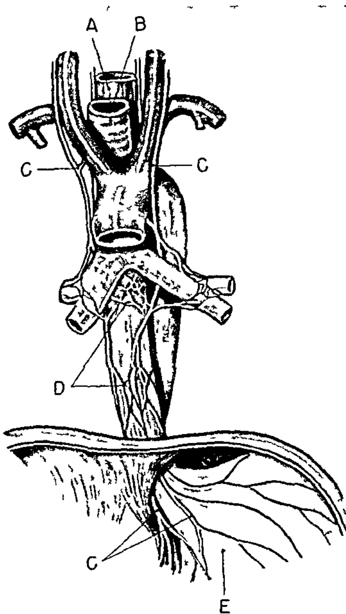


Fig 12 —Nerve supply of esophagus distribution above and below diaphragm A Esophagus B Trachea C Right and left vagus D Esophageal plexus F Stomach

Lymphatics of the Esophagus The lymphatics of the esophagus drain to the following group of glands

1 Lower deep cervical (in relation to the common carotid artery)

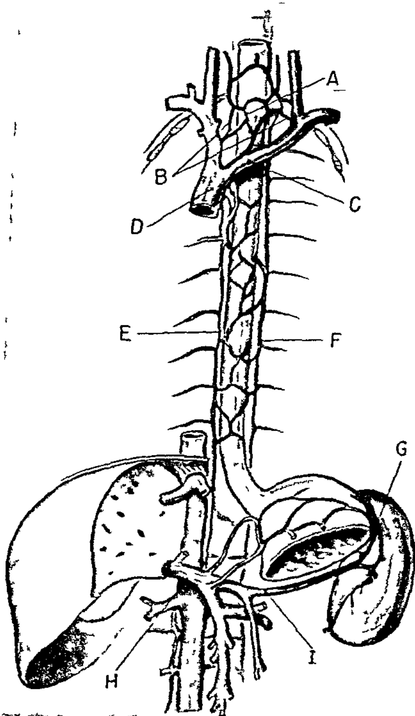


Fig 15—Veins of esophagus and stomach The venous return is through the inferior thyroid veins in its upper part through the azygos and hemiazygos in its middle part and through the short gastric and the coronary veins in its lower part A Esophageal venous plexus. B Inferior thyroid veins C Innominate vein D Superior vena cava E Azygos vein F Hemiazygos vein G Short gastric veins. H Portal vein I Splenic vein

2 Glands accompanying the recurrent laryngeal nerves
3 Bronchial

4 Posterior mediastinal (along the aorta)
5 Left gastric

The lymphatics enter the mediastinal and cervical lymphatic nodes so that if cancer of the esophagus is apparently present the nodes at the root of the neck must be carefully examined

Esophageal Arteries These are chiefly branches of the thoracic aorta

The esophageal arteries are four or five They take origin from the anterior aspect of the aorta and course downward to the esophagus, forming anastomoses along its course

Esophageal Veins The venous system corresponds to the arteries draining mainly to the thyroid veins above to the azygos and hemiazygos veins in the thorax and to the left gastric vein below Its main interest lies in the fact that the anastomosis between the left gastric vein and the lower esophageal veins (draining to the azygos and hemiazygos veins) represents one of the four important sites of communication between the portal and systemic venous circulation (fig 13)

Esophageal Nerves The nerve supply of the esophagus is derived from two sources sympathetic and parasympathetic (figs 8 12)

The sympathetic supply comes from three sources

1 Branches from the ganglionated sympathetic trunks both right and left (T-6-10)
2 Branches from the greater and sometimes lesser splanchnic nerves
3 Branches from the plexuses on the left gastric and inferior phrenic nerves from the celiac plexus

THE SMALL INTESTINE

Position and Length The small intestine is a narrow muscular tube about 22 feet in length It begins at the pyloric sphincter and terminates at the ileocolic sphincter where it joins the large intestine

The small intestine is attached to the posterior abdominal wall by means of its mesentery

There is some experimental evidence for the belief that there is a constant distribution of small intestine at least in the same person

Treves (1885) found that the position depended upon the size and shape of the surrounding organs especially the stomach and colon He stated that the intestine was disposed in an irregularly curved manner from the left upper quadrant of the abdomen to the right lower quadrant[4]

According to Mall the gut is arranged in spiral coils passing from the left hypochondriac area to the right iliac fossa successive coils being in the main parallel Starting from the duodenum there are two transverse folds in the left hypochondrium, followed by a long fold that goes across the body and back Some less distally transverse folds occupy the left iliac fossa The remainder is disposed vertically occupying the lower part of the umbilical area and pelvis and extending to the right so far as the large intestine will permit The end of the ileum rises from the pelvis into the right iliac fossa

There are frequently deviations from this arrangement

Remarkable variations are present in the length of the intestine, ranging from 13 to 37 feet

Movements The movements exhibited by the small intestine may descriptively be divided into two classes propulsive and non propulsive

Reverse peristalsis is not common in the small intestine, it occurs normally in the duodenum when bile is regurgitated into the stomach at the end of gastric digestion It is always present in examples of intestinal obstruction (fecal vomiting)

The pyloric antrum pyloric sphincter and the first part of the duodenum act as a coordinated unit When the antrum contracts the duodenum exhibits receptive relaxation in order to receive the evacuated chyme

Pyloric rhythm seems independent of gastric peristalsis (Todd Beaumont Foundation Lectures Series 9, 1930), but is closely coordinated with rhythm of the duodenal cap

Painter Todd and Kuenzel[5] found that "the typical neutral pattern of the stomach is expressed in a peristalsis of both stomach and duodenum wherein the waves follow each other at 20 second intervals The pylorus opens and closes every 20 seconds and evacuation of gastric secretion recurs with every systole

Slow peristaltic waves pass down the small intestine in its entirety at intervals varying from a few seconds to a few minutes

In addition to peristalsis there are also movements of a churning character—rhythmical segmentation These are alternating contractions and relaxations of successive segments of intestine which are not onwardly progressive in a coordinated manner—that of peristalsis for example

The rate of rhythmic segmentation of intestine is progressively slower in successively lower levels of bowel It is about 17 to 21 a minute in the duodenum and about 10 to 12 a minute in the ileum The amplitude of contraction, on the contrary is only about one third so great in the duodenum as in the ileum

How the movement of the small intestine is regulated is obscure The vagi increase the tone and motility of the small bowel and the sympathetic nerves have the reverse effect But it is found even after the vagus and sympathetic nerve supplies have been divided that normal, but slightly modified peristalsis continues Parts of the gut excised from the body exhibit rhythmic movements The normal intestinal movements are therefore probably controlled by means of local mechanical and chemical stimuli of the mucosa and causing contraction above the relaxation below the site of stimulation Auerbach s plexus probably carries the impulses which bring about this coordinated response

When a segment of the intestine for example is reversed by surgical operation waves of peristalsis continue to pass over the reversed segment in the same direction as before that is they move toward the duodenum after the operation

The belief that specific stimulation of the gut in any area induces contraction just above and relaxation just below the affected area is conveniently referred to as the law of the intestine

It is manifest then that the movements of the intestine are influenced by nerves but not in the manner of the esophagus and stomach The vagi are motor to the intestine the sympathetics are inhibitory however if as previously stated a section

of intestine is denervated the digestive movements seem to be normal proving the independence of intestinal motility

Blood Supply The normal pattern for the arterial supply of the intestines is that the mid gut (duodenum to middle of the transverse colon) is supplied by the superior mesenteric artery and *the hind gut (transverse colon to rectum) by the inferior mes* enteric artery

The mode of distribution of the arteries is by means of a series of arching branches that lie between the two layers of the mesentery of the tube

The venous return is over the superior mesenteric veins which unites with the splenic to form the portal vein

Lymphatics of the Small Intestine The lymphatic vessels are very numerous The lacteals arise in the villi These join lymphatics from the solitary nodules and Peyer's patches and form a distinct chain of lymphatic vessels that pass between the two layers of the mesentery to reach the thoracic duct

THE DUODENUM

The duodenum is so named because some ancient anatomist measured length by finger breadths (L *duodeni* twelve) This is the widest part of the small intestine and the only one not connected by a mesentery with the posterior abdominal wall Part of its anterior lateral surface is however covered with peritoneum and con sequently has a serous coat

Congenital Malformations Duodenal septa occur like atresia and diverticuli and are embryologic defects They are rare conditions

Congenital duodenal obstruction may occur as a result of aberrant vessels extrinsic peritoneal bands or malrotation of the gut Intrinsic causes are atresia stenosis or an intrinsic diaphragm

Duodenum Inversum Slight variations of the duodenal curve are frequently dis covered Addison[6] described no less than 40 distinct shapes of the part

The third or horizontal part of the duodenum instead of crossing the midline ascends behind the descending part and crosses the midline higher posterior to the head of the pancreas

Two forms of duodenum inversum are described one in which the position of the duodenum remains constant however the patient is moved about and the mobile form in which the segments of the duodenum alter their sites relative to one another

Duodenal Contour The first part of the small intestine is horseshoe shape with the convexity to the right side the concavity encloses the head of the pancreas

Contoural Deformities (1) Ulcer (2) diverticulum (3) duodenal redundancy (4) duodenitis (5) adhesions (6) foreign body (7) polyp (8) new growths (9) extra duodenal pressure from the gallbladder (10) pancreatic tumors (11) intestinal tu mors (12) abnormal curvature especially of the lower part

Gastroduodenal Junction The gastroduodenal junction can be recognized from the fact that at this site a small vein (vein of Mayo) crosses transversely and may be seen beneath the serosa

Duodenojejunal Flexure The end of the duodenum the duodenojejunal flexure is firmly held in place by a band of fibro-muscular tissue which descends upon it

from the right crus of the diaphragm and the tissues about the celiac axis Th[illegible] band is sometimes called the suspensory ligament of the duodenum (Treitz) I[illegible] serves also to support the mesentery

On the *left side of the terminal part of the* duodenum is the duodenojejunal fossa Normally it is occupied or filled by the convexity of the terminal part of the duodenum to which it serves as a bursa The suspensory ligament forms its upper border, its lower border being *formed by another fold* the duodenal *The* inferior mesenteric vein ascends near the left margin of the pocket This fossa is the anatomic cause of one form of intraperitoneal hernia, described in detail in the present writer's book[7] Another peritoneal recess lies *to the right of the duodenojejunal flexure (fossa of* Waldeyer)

The duodenojejunal flexure lies on the left side of the second lumbar vertebra below the pancreas in front of the left renal vessels The jejunum, at its beginning passes downward, forward and usually to the left If the transverse colon is displaced upward and the jejunum drawn tensely to the right, a folded edge of peritoneum containing muscular fibers appears passing from the flexure to the parietal peritoneum This is the suspensory ligament or muscle of Treitz, which is anchored to the left crus of the diaphragm The fossa which lies behind it is the superior duodenal fossa of Treitz, while that below is the inferior duodenal fossa Below this fossa the inferior mesenteric artery passes and near the left edge of the ligament, the inferior mesenteric vein (paraduodenal fossa)

To find the ligament of Treitz and the first loop of jejunum it is best (1) to displace the transverse colon and its mesentery upwards, (2) to follow the mesocolon downward and to the left The beginning of the jejunum and Treitz's ligament are found at the left of the second lumbar vertebra

The jejunum ileum extends from the duodenojejunal flexure to the cecum *It is* about 22 feet long The jejunum forms the upper two fifths of this structure and is found for the most part on the left side of the upper abdomen Its coils are disposed *in a transverse position The ileum forms the lower three fifths of this* section of intestinal tube and is situated mainly in the lower abdomen and pelvis

The blood supply of the duodenojejunal flexure derives from the right gastric and superior pancreatico-duodenal of the hepatic inferior pancreatico-*duodenal of the* superior mesenteric

The nerves are from the celiac plexus

Position and Mobility There is little definite information concerning either the position or mobility of the duodenum proper The various parts of the tube may vary in position

The duodenal position in the male varies as a rule with advancing age There is a definite tendency for the highest part *of the viscus (in the prone position) to move* downward most notably in the fifth and sixth decennia of life A duodenal high point found so high as T 12 although rare throughout life is most infrequent after the age of fifty

The great majority of persons show a high point opposite either L 1 or L-2 There is a definite shift towards L 2 after the age of fifty

The low point of the duodenum (in the prone position) the seeming mean is at a level a little below L 3

Friedman[8] of the Department of Anatomy, McGill University summarized his study of the position of the duodenum as follows

1 The mean position of the highest point of the first part of the duodenum is opposite the lower part of L 2 varying between T 12 and L 3

2 The variation is owing in part to a downward migration with age of the duodenal high point at a statical rate of about half a vertebra per decade

3 The mean position of the lowest point of the third part of the duodenum is opposite L 3–4 interspace varying between L 2 and L 5

4 The third part of the duodenum does not migrate downwards with age so that there is a constant tendency towards shortening of the vertical diameter of the duodenal curve as age advances

5 The most fixed point of the duodenum is the duodenojejunal flexure opposite L 2 (plus or minus) one vertebra It does not migrate with age

6 Depending on the state of fullness of the stomach and intestine postural changes may induce an excursion of the duodenum of about two vertebrae (plus or minus) Downward excursions occur about the duodenojejunal flexure at fixed pivot with consequent shortening of the vertical duodenal diameter Upward excursions involve the whole duodenum including the duodenojejunal flexure

Duodenal Divisions Anatomically the duodenum consists of two main divisions the duodenal cap and the whole of the remainder of the duodenum

For convenience of description the duodenum is divided into four parts

Relations of the Duodenal Parts First Part (Pars Superior) The first part of the duodenum is smooth because it has no valvulae conniventes It is known as the cap or bulb

Mayo held that it belongs rather to the stomach than to the small intestine because it is supposed to have developed from the original fore gut

The peculiarity of the human duodenal bulb is the formation of the fornix In this way the duodenal part of the sphincter lies outside the gastric part on the lesser curvature site

The first part of the duodenum is two inches long directed from the pylorus upward backward and to the right reaching the neck of the gallbladder This first inch is invested with peritoneum but the second inch is covered only anteriorly

Anteriorly and superiorly are the liver and gallbladder Posteriorly is the common bile duct portal vein hepatic artery, gastroduodenal artery Superiorly the opening of the lesser sac and lesser omentum Inferiorly the head of the pancreas

Second Part (Pars Descendens) This part passes from the neck of the gallbladder to the lower border of the 3rd lumbar vertebra It is from three and a half to four inches long Its posterior surface is devoid of peritoneum and lies on the inner aspect of the right kidney On its inner left side it is in contact with the head of the pancreas and common bile duct The latter pierces the duodenal wall about three inches from the pylorus The duct enters the intestinal wall after joining with the pancreatic duct to form the ampulla of Vater about 10 cm from the pylorus

Anterior are the transverse colon liver and gallbladder and small intestines Posteriorly are the right kidney suprarenal glands renal vessels and inferior vena cava To the left are the head of the pancreas bile duct and pancreatic duct On the right side is the right flexure of the colon On the medial aspect three and one half to four inches from the pylorus is the duodenal papilla on which is the orifice for both the bile and pancreatic ducts

Third Part (Pars Inferior) This is about four and one half to five inches long It passes from right to left across the spine, ascending from the third to the second lumbar vertebra and ending in the jejunum on the left side of the spinal column This part of the duodenum lies below the transverse mesocolon and is covered anteriorly by peritoneum except where the root of the mesentery crosses it Anteriorly is the superior mesenteric vessels and plexus Posteriorly, the aorta, inferior vena cava, crura of the diaphragm, left psoas and the left renal vessels Superiorly, is the pancreas

Fourth Part (Pars Ascendens) This part is oblique

Peritoneal Relations of the Duodenum The first inch of the first part of the duodenum is completely surrounded by peritoneum, the remainder of the first part at its lower aspect is not covered by peritoneum (retroperitoneal)

The second part—here the left and posterior surfaces are not covered by peritoneum

The third part—the upper and posterior surface of the duodenum are not covered with peritoneum

Duodenal Fossae The present writer has already described the duodenal fossae as follows[9]

The Paraduodenal Recess (Recessus Duodenojejunalis, Land ert Broesike)

This inconstant recess lies slightly to the left of the ascending part of the duodenum The stoma which is medially directed is crossed anteriorly by the inferior mesenteric vein accompanied sometimes by the ascending branch of the left colic artery, it is formed by a ridge—the plica venosa—composed of the inferior mesenteric vein posteriorly the fossa is delimited by the parietal peritoneum the renal vessels the left ureter and a portion of the left kidney and inferiorly by the mesenterico mesocolic fold This fossa disappears as a rule in the first decade of life

It is of interest to note wrote A K McGregor[10] that hernia into the paraduodenal fossa may be associated with hemorrhoids owing to pressure on the inferior mesenteric vein by the gut entering and leaving the fossa

The Retroduodenal Recess

This fossa the largest of the duodenal fossae is present at times It is a pouching in front of the aorta and behind the third and fourth parts of the duodenum extending in an upward direction almost as far as the duodenojejunal junction The orifice is directed to the left and downward

The Duodenojejunal or Mesocolic Recess

This recess is found to the left of the aorta between the top of the duodenojejunal flexure and the overlying root of the transverse mesocolon The orifice is directed forward

Moynihan states that when this fossa is present strangely enough no other form of duodenal fossa has been observed (This is equally true of the retroduodenal)

The duodenojejunal fossa may be revealed by drawing the jejunum to the right and downward following upward traction of the transverse colon

Moynihan s Classification of the Peritoneal Fossae

Moynihan s classification of the fossae in relation to retroperitoneal hernias is as follows

(1) The superior duodenal fossa
(2) The inferior duodenal fossa (Treitz)
(3) The paraduodenal fossa (Landzert)
(4) The mesenterico-parietal fossa (Waldeyer)
(5) The mesocolic fossa

Fossae of infrequent occurrence and of little practical importance according to Moynihan are

(6) The posterior duodenal fossa (Gruber)
(7) The duodenojejunal fossa
(8) The recessus inter mesocolicus transversus
(9) The infraduodenal fossa

Direction of the Duodenal Parts Beyond the narrow part of the bulb for an inch the duodenum passes horizontally outwards toward the right and backwards and then turns downwards to form the second or vertical part

The second part of the duodenum is directed downward along the right side of the vertebral column to the fourth lumbar vertebra It is about three and one half inches long

The third part of the duodenum lies across the 3rd lumbar vertebra from which it is separated by the great vessels and is about three inches long Its direction lies almost horizontal but slightly upward and its last inch is crossed from above downwards by the superior mesenteric vessels and the root of the mesentery

The fourth part of the duodenum passes upward and to the left just beyond (to the left of) where the superior mesenteric vessels cross the duodenum It turns forwards in the root of the transverse mesocolon and emerges from the lower surface of this at the beginning of the jejunum It is as a rule attached to the mesocolon by a fold of peritoneum known as the band of Treitz This is an important landmark in the abdomen It is a guide to the duodenojejunal flexure

The Calibre of the Duodenum Beyond the narrow part of the apex of the bulb the duodenum is wider up to one and three-quarter inches in diameter

The Suspensory Muscle This is a small flat triangular muscle which arises directly above the hiatus aorticus from the band of fibers of the lumbar part of the diaphragm It runs downwards anterior to the coelic plexus and behind the pancreas its fibers diverging downward

Duodenal Lymphatics The lymphatics are closely related to those of the pancreas by direct anastomoses of lymph vessels or indirectly by many small branches between the larger vessels

They consist of an anterior and a posterior set which open into the superior pancreatic and pancreatico-duodenal lymph glands on the anterior and posterior aspects of the groove between the pancreas and the duodenum

Communication is also established with the lymphatics of the appendix and ascending colon

Blood Supply of the Duodenum The duodenum is supplied with blood by the superior pancreaticoduodenal branch of the gastro-duodenal and the inferior pancreatico-duodenal branch of the superior mesenteric artery These two anastomose and form a kind of dual arterial chain extending along the groove between the duodenum and the head of the pancreas one half being anterior and the other posterior to the pancreas

The gastroduodenal artery begins at the superior border of the first part of the pancreas and gives off a retroduodenal branch before dividing into two trunks one the right gastroepiploic courses to the left along the greater curvature of the stomach the other the superior pancreatico-duodenal extends downwards to the

right along the concavity of the duodenum contributing many branches—the rami duodenales

The inferior pancreaticoduodenal branch arises from the right side of the superior mesenteric artery where it lies along the ascending duodenal segment extends from left to right along the duodenal curve and anastomoses with the superior pancreaticoduodenal The duodenal branches of Theile arise from the left side of the superior mesenteric artery and extend to the duodenojejunal angle Both the superior and inferior pancreatico duodenal arteries divide into two branches which pass anterior and posterior to the head of the pancreas and anastomose to form anterior and posterior arterial arcades which extend along the concavity of the duodenum

From the convexity of the arterial arcade branches extend to the two surfaces of the duodenum From its concavity branches extend to the pancreas

Wilkie[11] first clearly described the supraduodenal artery, usually stemming from the gastroduodenal or hepatic arteries, as the source of supply to, in the main, the upper two thirds of the anterior and one third of the posterior wall of the first part of the duodenum He noted also that the upper part of the first one half inch of the duodenum is supplied in about 50 per cent of persons by branches from the pyloric or right gastric artery Recurrent branches from the right gastroepiploic or superior pancreatico duodenal arteries supply the lower anterior part of the first inch of the duodenum, the retroduodenal branches from the gastroduodenal artery supplying the posterior part

The supraduodenal artery is actually an end artery and the anterior duodenal anemic spot ' of Mayo (S G O , v 6, p 600 1908) seen when the hepato-duodenal ligament is tensed corresponds to the center of this relatively poorly supplied area

The blood supply of the first part of the duodenum is poor because of its situation on the borderline between the area supplied by the coeliac axis and the superior mesenteric

The retroduodenal artery, a branch from the trunk of the gastroduodenal, usually supplies the lower two-thirds of the posterior surface

Branches from the superior pancreatico-duodenal artery supply the terminal part

Arteries of the Second and Third Parts of the Duodenum The anterior and posterior pancreatico duodenal arches are the major sources of arterial supply to the second and third parts of the duodenum These arches represent an anastomatic junction between the coeliac axis and the superior mesenteric artery

Arteries to the Fourth Part of the Duodenum The superior mesenteric artery the inferior pancreatico-duodenal artery and the first jejunal artery generally contribute twigs to the fourth part of the duodenum The duodenojejunal flexure itself receives twigs from at least two of these three sources

The Arteries of Origin of the Pancreaticoduodenal Arcades The gastroduodenal artery descends medial or anterior to the lower common duct behind the first part of the duodenum and at its inferior border divides into the inferior gastroepiploic and anterior superior pancreatico-duodenal arteries During this course it gives off the supraduodenal posterior and superior pancreatic duodenal retroduodenal and pancreatic branches and occasionally the supraduodenal artery

The veins accompanying these arteries end in the superior mesenteric and splenic

veins and thence their blood reaches the portal veins which are directly posterior to the first part of the duodenum and separated from it by the bile duct and gastroduodenal artery

The duodenal cap is separately supplied by a small branch from the gastroduodenal artery (in 50 per cent of persons) or sometimes from the hepatic (in 40 per cent) This is called the supraduodenal artery It is an end artery

Duodenal Nerves There are some contrary opinions among anatomists concerning the nerve supply to the duodenum Horton[12] for example found that the myenteric plexus is continuous from the stomach to the duodenum

The nerves are derived from the solar plexus and after piercing the outer longitudinal muscle layer form the intramuscular plexus of Auerbach

The nerves continue obliquely through the circular muscular layer and form the plexus of Meissner within the submucous coat

The Jejunum

The name jejunum is from the Latin *jejunus* empty '

Position The jejunum lies for the most part inside the anchorage of the large intestine

In consequence of the freedom of motion of the coils of the small intestine a definite and constant position of the different parts is not possible In a general way however, the coils are placed in an irregularly curved manner from left to right and the jejunum in its entirety is largely above the ileum and occupies the umbilical and left lumbar and iliac areas while the ileum is found in the pelvis, the hypogastrium and the right side

After the coils of the jejunum are arranged transversely and those of the ileum vertically some coils of the jejunum corresponding to the longest part of the mesentery are found in the pelvis

The mesentery is the suspensory ligament of the jejunum and ileum or of all the small intestine except the upper 25 to 10 to 12 inches

Relations The jejunum commences at the area where the small bowel turns abruptly downward upon the left side of the 2nd lumbar vertebra where the mesentery begins

There is no sharp demarcation to distinguish the jejunum from the ileum

The first part usually rests in the left hypochondrium and passes to the umbilical area turning into the right half of the body and curves there passing backward again across the median plane thereupon it forms several loops in the left iliac fossa passes to the right again and finally descends into the small pelvis Its terminal part passes upward again curves to the right around the margin of the right psoas muscle and passes to the iliac fossa terminating in the ileum

Directions The jejunum tends to be above and to the left and the ileum below and to the right

The Middle Calibre The jejunum is wider than the ileum

Length This part of the small intestine is about seven and one half feet long It constitutes the first two-fifths of the small intestine

Blood Supply of the Jejunoileum This is derived from the vasa intestini brevis of the superior mesenteric artery They anastomose within the mesentery and form a

number of arterial arcades which give rise to the vasa recta Pursuing a straight course they enter the mesenteric border of the intestine without anastomosing with each other Within the intestinal wall the anastomoses between the vessels are few This is an important fact to keep in mind in effecting an enterostomy or entero anastomosis In these procedures it is essential to avoid injury of the vasa recta of the divided edge

On the upper part of the bowel the mesenteric vessels are distinctly larger than opposite any other part of the intestine, they grow smaller as they proceed downward until about the lower third of the intestine they remain about the same size so far as the ileocecal valve

The main branches of the superior mesenteric artery unite to form primary loops in some parts secondary or even tertiary loops are observed From these the vasa recta run to the bowel

The mesenteric veins display a somewhat similar arrangement to the arteries

Differences Between the Ileum and Jejunum In the mesentery of a loop of jejunum the vessels can be seen framing "windows " whereas at the ileum the fat hides the vessels and overlaps the gut

It is commonly found during surgery that the jejunum is empty while the ileum still retains some of its contents

The circular folds are large and numerous in the jejunum and small and few in the ileum The walls of the jejunum are therefore thicker and redder

A differential point based on the blood supply is stressed by McGregor[13] One or two arterial arcades in the mesentery with parallel vessels one and a half inch long going to the gut Ileum two or three arterial arcades in the mesentery with parallel vessels one half inch long going to the gut "

The jejunum is wider and more vascular than the ileum The lunettes are more numerous and the vasa recta are longer than in the ileum

The mesentery of the ileum is less transparent than that of the jejunum

In determining the direction of a certain segment of the small bowel it must be remembered that the parietal attachment of the enteric mesentery runs obliquely downward from left to right Withdraw a loop of gut Hold it with its long axis parallel to the midline of the body Put the mesentery on the stretch Introduce the hand along the mesenteric surface and glide it along backward to the spine If the hand remains on the same side of the mesentery until its parietal attachment is reached there is no torsion of the particular loop and that part in the upper end of the wound is proximal Also to further ascertain which end of the bowel is proximal and which distal the method of Monk is of value if the mesentery proceeds upward and to the left we have the proximal end if the mesentery proceeds downward and towards the right we are dealing with the distal end

CHAPTER II

Histology

The Esophagus

Epithelium The squamous epithelium of the esophagus is firmly attached by the long papillae of the subjacent lamina propria

The stratified epithelium of the esophagus ends abruptly at the cardiac orifice and becomes continuous with the columnar mucus-secreting epithelium of the stomach It is of significance to note according to Rector and Connerley,[14] that some esophageal lesions have their roots so to say in occasional patches of epithelium which mimic the characteristic gastric mucosal lining

Because no absorption takes place through the lining epithelium there is not the same requirement for lymphatic tissue to filter the tissue fluid formed in the lamina propria as there is in other parts of the tract The relatively little lymphatic tissue present is found in those areas where the ducts of glands pass through the lamina propria

Muscularis Mucosa The muscle is all striated in the upper third mixed in the middle third and nearly all smooth in the lower third

(The striated muscle of the upper part of the esophagus—and the pharynx—is an exception to the general rule that striated muscle is voluntary)

The fibers of the longitudinal layer of the muscular coat take origin from the posterior surface of the cricoid cartilage partly surrounding the lateral aspect of the esophagus and fanning out upon the whole circumference of the tube The longitudinal layer is usually anchored by narrow bands of fibers to the posterior surface of the trachea of the left bronchus with the mediastinal pleura (left) and with the muscle fibers which surround the diaphragmatic esophageal opening

The longitudinal muscle fibers coil in and out of the folds of the mucosal membrane and are thickest where they are deepest namely at the terminal part of the esophagus The axis of the folds is vertical—similar to the axis of the muscle

Glands of the Esophagus There are some mucous glands scattered in the submucosa These are called the esophageal glands In addition there are some in the lamina propria of the mucous membrane these are most numerous near the stomach and because they are similar to those in the cardiac part of the stomach they are termed cardiac glands

The mucous glands are plentiful in the upper third of the esophagus The cardiac glands are simple branched tubular glands found mainly near the extreme ends of the esophagus These glands contain cells distinctive of the epithelium of the cardiac end of the stomach

The Stomach

Gastroesophageal Junction Longitudinal section through the esophagus at its junction with the stomach reveals the following structural characteristics

1 Sudden change from stratified squamous to simple columnar epithelium which is thrown into elevations and depressions

2 The mucosa is of increased thickness The muscularis mucosae is continuous across the union This is equally true of the submucosa and muscularis

3 The circular muscle layer is also of increased thickness and forms the cardiac sphincter '

The Serous Coat The stomach conforms to the general structural plan of the alimentary canal, it has mucous, submucous, muscular and serous layers

From the commencement of the esophagus to the end of the rectum the alimentary canal is arranged in the form of a tube, consisting of a mucous coat inside with a muscular coat outside the tube being united by loose connective tissue—the submucous coat

Muller[15] in a great series of studies, showed that the number of stomach layers varies separate muscle bundles may be above or below each other, depending on the state of tonus of the wall at the particular time In general the muscle increases in strength towards the pylorus The contraction wave therefore becomes deeper as it approaches this part

In the main the movements of the fundus and antrum are distinctly different Those of the fundus are chiefly of the nature of tonic contractions The food is finally pressed into the actual motor segment, the antrum Here the movements are strong and consist of rhythmic contractions and relaxations as demonstrated in the studies of Luciani[16] There is an actual systole and diastole

The serous coat of the peritoneum, extends all over the stomach except at three sites namely

(a) A variable area near the cardiac opening is in contact with the diaphragm without any peritoneal covering

(b) Along the lesser curvature where two layers of the lesser omentum leave a triangular space as they separate to become continuous with the serous coat of the stomach

(c) Along the greater curvature, where the two layers of the great omentum leave a similar but narrower space

(In both of these curvature spaces vessels and nerves of the stomach pass the left and right gastric in the space along the lesser curvature the left and right gastro-epiploics at the greater curvature)

Muscular Coats The muscular coat is arranged in three layers of non striped muscle and in this respect differs from other parts of the alimentary tube, which have only two—an outer longitudinal one and an inner circular

The three coats are

1 Longitudinal continuous with the longitudinal muscle of the esophagus The fibers which are most superficial are continuous with the longitudinal muscle of the duodenum The deeper ones especially along the lesser curvature where they are thickest end at the pyloric sphincter

The longitudinal coat is deficient anteriorly and posteriorly over the body of the stomach When the longitudinal muscle contracts the stomach becomes shorter

2 The circular layer this layer is very thick at the pylorus where a sphincter is

formed Here the circular fibers end abruptly at a fibrous septum and are *not* continuous with the circular layer of the duodenum

The circular layer is able to contract like a sphincter It is not as previously stated, a real sphincter It may contract simultaneously with the longitudinal muscle

The second layer of the tunica muscularis covers the whole stomach with the exception of the fundus the uppermost fibers arising at the right side of the cardia form only incomplete rings The layer is directly connected with the circular layer of the esophagus and of the duodenum and projects at the pylorus into the interior of the stomach as a reinforced ring—the pyloric sphincter

3 The deepest layer is of oblique fibers most of them passing from the cardiac incisura towards the lower part of the body of the stomach Near the greater curvature they blend with the circular muscle layer

The inner layer is incomplete and is made of oblique bundles of fibers that hang in inverted loops from the right part of the the fundus The lateral bundles fan out towards the greater curvature As they descend the medial bundles course along the lesser curvature forming two fairly definite muscle ridges on the anterior and posterior walls These ridges lie in the folds of mucous membrane that run along the lesser curvature When they contract they bring the edges of the mucous folds together converting the groove between them into a canal

The oblique muscle which is continuous to the circular muscle fibers of the esophagus forms a sling from the esophagus down both sides of the lesser curvature When this muscle contracts the body of the stomach assumes a perpendicular position while the pars pylorica remains in a horizontal one When the oblique muscle is relaxed and the longitudinal muscle contracts the entire lesser curvature is concave and the stomach is crescent shaped

(In the fundus the muscle bundles run in various directions)

Gastric Mucosa The tunica mucosa of the stomach is separated from the tunica muscularis by the tela submucosa It is of a grayish red or rose color and is demarcated at the cardia by a sharp line from the more whitish mucous membrane of the esophagus When the stomach is contracted it forms with the tela submucosa, numerous folds (rugae) Longitudinal folds are found along the lesser curvature and in the pylorus in other places the folds are arranged in an irregular network These folds vanish entirely when the stomach is greatly distended

At the pylorus there is always a fold usually circular the pyloric valve which is drawn forward by the pyloric sphincter muscle

Besides the larger folds of the stomach there are still smaller elevations areae gastricae incompletely separated from one another

The mucosa cannot relax and contract as does the muscularis When the muscularis is greatly relaxed in the filled stomach the mucosa is pulled smooth When the muscularis is contracted in the empty stomach the mucosa (instead of contracting) is thrown up into the characteristic folds which run the longitudinal way of the organ

Sphincters There are four sphincters in the gastrointestinal tract the cardiac at the junction of the esophagus and stomach pyloric at the opening of the stomach into the duodenum ileocecal at the area where the ileum joins the colon and the anal sphincter

Anatomically, it is difficult to discern the muscle fibers which act as a cardiac sphincter However, a physiologic sphincter is present in this area

The cardiac sphincter is a widespread thickening of circular muscle of the lower end of the esophagus and upper part of the stomach This is sufficiently obvious to be called a sphincter, but on contractions forms a cardiac canal rather than a cardiac orifice (Proc Roy Soc Med Sect , Dec *1916*) The sphincteric arrangement is situated entirely below the diaphragm

(The presence of the musculus sphincter entri—pre pyloric sphincter—has been known since *1679* when Wepfer, cited by Cathcart,[17] described it for the first time Later Spallanzani Haller and others also described it Beaumont however gave the first complete physiologic description of the so called "transverse band in man)

The cardiac sphincter, like all others is always closed unless something is passing through it When the stomach is empty the sphincter is weakly contracted when food is present the sphincter contracts strongly to prevent regurgitation

According to McGregor[18] the pyloric sphincter bulges the mucous membrane inwards, forming an annular ridge that either closes the pyloric orifice or reduces it to a width that varies according to the degree of contraction (It resembles the external uterine os)

Specific Areas of the Stomach

1 Cardiac
   (a) Simple columnar epithelium
   (b) Goblet cells are absent in all parts of the stomach in contrast to the intestine There may be rare exceptions
   (c) No gastric glands extend into the submucosa *(It is maintained by some* histologists that the cardiac glands are not, as might be expected, found in the cardiac area of the stomach instead, they are restricted to a small area of gastric mucous membrane *extending not more than about 4 cm* from the junction of the esophagus with the stomach)
   (d) Cardiac glands of the stomach, according to other histologists occupy *only a limited area adjacent to the esophagus*
   (e) Bodies of the cardiac glands become shorter when passing from the *cardiac area to the fundus of the stomach*
2 *Fundal*
   (a) The fundic glands are found in almost the entire stomach the pyloric glands are found as the term denotes in the pyloric part

The so-called fundic glands are the principal glands of the stomach (They were first called fundic glands by Oppel) That the term is a misnomer is proved by the fact that the glands not only occupy the small and relatively unimportant fundus but also the large and physiologically important body of the stomach In view of this fact Schwalbe (1912) proposed to call these glands body glands' Lehner (1928) suggested that they be called chief glands because the body chief cells are found only in this kind of gland while the parietal cells are found in all three varieties of glands

The cells forming the walls of the glands are continuous with the epithelium covering the gastric mucosa but differ from the latter both structurally and functionally

The cells of the glands of the *body of the stomach* are of three varieties (a) mucous

cells, (b) chief or zymogenic cells and (c) parietal or border cells The mucous cells are situated in the narrow superficial part of the gland tubule called the neck The chief or zymogenic cells form a continuous lining for the deeper part or body of the gland tubule The parietal or border cells do not form a continuous layer but lie scattered along the tubule to the outer side of the chief cells

Lymph Channels The lower half of the greater curvature has more submucosal lymph channels than the upper half This tends to explain why malignant tumors of the upper half of the greater curvature may become extremely large before metastases occur Furthermore since there is *no* communication between pyloric and duodenal lymphatics it is therefore manifest why an extension of pyloric cancer to the duodenum is rare However lymph channels from the lower half of the greater curvature ultimately unite with the deep coeliac glands which in turn communicate with the lymph glands in the transverse fissure of the liver and thereby account for frequent jaundice in patients suffering from pyloric malignancy

The Small Intestine

The small intestine like the stomach is divisible into three segments the minute structure of which gradually grades one into the other Throughout its extent the small intestine differs greatly from the stomach in the presence of villi and in the characteristics of the surface epithelium

In the stomach the surface cells except for occasional dead and dying ones appear alike and function in the gradual secretion of mucus In the intestine on the other hand the cells are divisible into two categories The first form mucus but before its expulsion on completion of the secretory cycle they become greatly distended (goblet cells) The second are slender and characterized by the possession of an evenly striated (cuticular) border next to the lumen and serve in the main in absorption of water and various products of digestion from the lumen (absorptive cells)

Characteristic Structures of the Small Intestine Four anatomic structures one sub divided into two parts may be considered as characteristic of the small intestine They are

1 Mucous Membrane Throughout its extent the mucous membrane is pitted by the minute orifices of glands called crypts of Lieberkuhn They are simple tubes

The mucous membrane about an inch beyond the pylorus is cast into circular or spirally disposed folds Unlike the folds of the stomach these do not disappear when the bowel is distended or stretched The folds vary both in length and depth (Kerckringi)

They are absent in the upper part of the duodenum appear in the descending part and are especially numerous and large in the inferior division and in the upper third of the jejunum Farther on they diminish again and are usually completely absent in the lowermost part of the ileum They run approximately at right angles to the long axis of the intestine and as a rule extend over only a part of the circumference A number of folds form complete rings and others encircle the intestine in a spiral manner In the upper part of the intestine they are longer and higher than in the lower part

The papilla duodeni is a small projection near the middle of the descending part of the duodenum

Each villus is a minute, finger like projection of mucosa In its long axis lies a lacteal vessel which communicates with the larger lymphatics in the submucous layer

The villi are conspicuously absent over certain low oval protuberances called Peyer's patches These are aggregated lymphatic nodules of unknown function and are best seen in the ileum

2 The Submucosa
3 Muscularis
 (a) Thick inner circular layer
 (b) Thinner outer longitudinal layer
4 Tunica serosa

Villi The villi are finger like projections of mucosa encircled by simple columnar epithelium with a striated border

The intestinal villi are a little more than half a millimeter in length and are found in all parts of the small intestine—from the beginning of the duodenum to the end of the ileum where they cease abruptly at the ileo-colic valve The villi are large and more numerous in the jejunum than in the ileum

Paneth Cells At the bases of the pits especially those into which Brunner s glands do not open are a few Paneth cells clearly marked by many large eosinophil granules

(In addition to the four kinds of cells —goblet and absorptive of the surface mucus of Brunner s glands and Paneth of the pits—is a fifth variety called enterochromaffin because it is intestinal and gives positive chromaffin reaction not unlike that of the medullary cells of the adrenal gland)

The Duodenum

Brunner s Glands They are a direct continuation of the pyloric glands of the stomach which they resemble, except that they lie in the submucosa instead of the mucosa

The glands of the duodenum were first mentioned in 1679 by Wepfer, but nine years later Brunner (or Von Brunn) described them in detail Middledorp (1846) called them Brunner s glands "

These glands are present in the duodenum in all species of mammals They are most abundant distal to the pylorus and they gradually diminish in number toward the duodenojejunal junction This is especially true in man where they are sharply confined to the duodenum only occasionally falling before or extending beyond the beginning of the jejunum

Their chief anatomic peculiarity is their position in the duodenum in relation to the muscularis mucosae

They are branched tubular areolar glands (mucous variety) lined with large cells

Villi In the duodenum the villi are broad, leaf like with the crypts of Lieberkühn at their bases which extend to the muscularis mucosae but do not penetrate it

The Duodenal Bulb The bulb is different from the rest of the duodenum in three respects

1 It is almost entirely covered by peritoneum and is movable except at the apex which is fixed by being continuous with the retroperitoneal part of the duodenum

2 The duodenal bulb is lined with mucous membrane which is thinner and smoother than that which lines the rest of the duodenum and is not thrown into transverse folds to an equal extent

The submucous coat contains arteries which are smaller fewer and which do not anastomose so freely

3 This part of the duodenum is the one where ulcers occur in all except 2 per cent of the afflicted It is usually full of food during gastric digestion The remainder of the duodenum is almost empty

The Jejunum

Villi These are higher and more slender with a more extensive development of the plicae circulares than in the duodenum

There are more goblet cells than in the duodenum

Solitary nodules do not extend into the submucosa

The nodules of lymphoid tissue are of two kinds—solitary and aggregated The solitary lymphatic nodules are rounded whitish bodies all along the mucous membrane They usually bulge the mucous membrane slightly The aggregated lymphatic nodules are formed of a large number of small nodules closely packed together They are largest and most numerous in the lower part of the ileum gradually diminish in the higher part and are few or absent in the jejunum They are placed on the side of the gut farthest from the mesentery

The Large Intestine

The Colon Some of the relevant facts in relation to the colon are as follows

(a) The mucosa is relatively smooth as compared with that of the stomach or small intestine
(b) There are no villi
(c) The glands are lined with simple columnar epithelium
(d) Goblet cells in greater profusion than in the small intestine
(e) Tubular glands.
(f) Paneth cells absent
(g) Nodules of lymphoid tissue in abundance
(h) Outer longitudinal muscle layer consists of three thick components (lineae coli)
(i) Serosa contains lobules of fat comprising hanging projections—the appendices epiploicae

CHAPTER III

Incidence

Race It has long been known that the incidence of gastric cancer differs among races the world over

Illustrative of the varying incidence were the necropsy records of the Department of Pathology of the Los Angeles County Hospital It was possible there to make a comparative study of the incidence of gastric cancer in members of the three great races of mankind—Caucasoid, Negroid and Mongoloid There were 35 293 gastric cancers found at necropsies in the period 1918 to 1947

The Chinese had no examples of the disease and the Filipinos only one There were 21 among the Japanese but the highest incidence was found among the Mexicans, accounting for 1 3 per cent of all deaths and 13 6 per cent of all deaths attributable to gastric cancer Among the Mexicans the disease caused a smaller percentage of all deaths than among Caucasoids (1 3 per cent as compared with 2 3 per cent)

In Negroids gastric cancer held second place

That the incidence of cancer of the stomach in different European countries varies considerably was shown in the report of the Commission du Cancer of the League of Nations (1927)

In 1936 Cramer wrote that whereas cancer of the stomach accounts for 50 per cent of all examples of malignant disease in most European countries in England there is only a 25 per cent incidence

Gastric cancer apparently has worldwide racial sex and social differences

The stomach is the most common site for cancer in the human body About 40 000 people die of this variety of cancer in the U S A , each year with a death rate of about 30 in every 100 000 population

Statistical data reveal that 50 3 per cent of alimentary cancers occur in the stomach 25 9 per cent are found in the rectum The colon average appears *to be 10 9* per cent and that of the small intestine (which is relatively immune to primary cancer) accounts only for 1 2 per cent

The racial incidence varies from 25 per cent of all cancers in Great Britain to about 40 per cent in the United States and over 50 per cent in some Continental countries[19]

Gastric cancer is much commoner among the poor than among the rich

In all civilized countries where statistics are available gastric cancer however seems to be the main cause of death from cancer, accounting for 13 000 deaths annually in Great Britain and about 40 000 in the United States—i e 33 per cent of all cancer deaths[20]

Friedenwald many years ago found that 5 2 per cent of gastric cancers occurred in Negroes

Occupation and Social Strata It cannot be stated definitely that any occupation

predisposes to gastric cancer Formerly it was believed that there was a preponderance of the disease among farmers

The importance of the mode of life in the etiology of cancer in the upper part of the alimentary canal was shown by Cramer in figures derived from the Registrar General s Decennial Supplement (England and Wales) for 1921 It was found that there is a lower incidence of gastric cancer in Social Class I that is, the upper and middle classes, than in any other five classes into which the Registrar General divided the country

Sex The ratio between men and women is different for each race

Considering mortality from all cancer the rate in the registration states (1900) has been rising more rapidly among men than among women The recorded death rate from gastric and hepatic cancer rose rapidly in both sexes from 1900 to 1915 and in males the rise continued until about 1922 Since 1922 the recorded rate for women has shown a clear decline but the rate for males has declined only slightly

Age There is no cancer age While the incidence of cancer in childhood and adolescence is of course less frequent than in later life, it must be borne in mind that malignancy is not avoidable at any age

Gastric cancer is a relatively rare disease in persons 30 years of age and younger In 1941 McNeer [1] reviewed the world literature and found 501 reports of patients below the age of 31 All in all he reported an incidence of 0 7 per cent In the early literature Welch[m] reported an incidence of 2 8 per cent of gastric cancer in this group of a total of 2 038 patients

Recently Walters and his coworkers [3] collected 24 examples of gastric cancer between the ages of 24 and 29 from a total of 2 772 resected cancers of the stomach

A survey made in the Department of Internal Medicine at the University of Michigan Hospital over a 20 year period showed that there were 1 913 cancers out of a total of 453 400 registrations This was an incidence of 0 42 per cent Of the 1,913 cancers during this same period 20 (1+ per cent) occurred in patients below the age of 32

The age of onset of esophageal malignancy is relatively late the average age being between 55 and 60 and rather less among women than among men

In an analysis of 30 000 reports of cancer Welch[24] found that the stomach was involved in 21 4 per cent of persons based on a study of 30 000 necropsy reports of cancer patients

Mortality reports in 1916 indicated that gastric cancer furnished nearly 38 per cent (or about 30 000 deaths) of all cancer deaths

In a survey comprising 124 827 autopsies from 42 German institutions of pathology between 1925 and 1933 Dormanns [5] found that cancer of the stomach lung and rectum were the most common of all malignancies Of 23 139 deaths attributable to malignancy in patients over 20 years of age 8 per cent were caused by gastric cancer

Statistics reported in the United States show cancer of the esophagus was only surpassed by gastric cancer in frequency of malignant tumors of the gastrointestinal canal

More than 75 000 deaths from cancer of the stomach were reported in the United States in 1913 It was estimated that there were fully one half million deaths from malignant disease in the same period throughout the world

In 1927 there were 103,578 deaths from cancer in the Registration Area of the United States Of these 36,879 were from cancer of the stomach and liver

The United States Health Reports for 1936 show a total of deaths from cancer of 142 613 Of these 19 per cent or 27,241, were owing to gastric cancer

In Russia cancer of the stomach is found among 30 to 40 per cent of patients afflicted with malignant tumors and shows the highest mortality rate More than 50 per cent of patients examined by the Central Oncologic Institute from 1925 to 1934 were found to be incurable Between 1932 and 1936 only 12 2 per cent of all patients admitted to the Institute were operable

The Surgical Department of the Sklifosofski Institute reported 1 020 patients suffering from gastric cancer between 1928 and 1938

The highest recorded death rates from gastric cancer and of the duodenum in the United States in 1930–32 occurred in Northern states from the Atlantic to the Pacific In the Southern states the rates were uniformly low, Louisiana being the only one that did not fall among the eleven lowest states

In 1938 there were 150 000 deaths in the United States from cancer 27,000 (approximately 18 per cent) attributable to gastric cancer

Livingston and Pack[26] (1939) furnished a diagram showing the number of deaths in fifteen years of United States wars in fifteen years of traffic accidents from 1923 to 1938 and an estimated figure for deaths from gastric cancer in fifteen years The figures were

War deaths	244 357
Traffic deaths	441 912
Gastric cancer	600 000

The census figures covering deaths from cancer of the esophagus and gastrointestinal tract in the United States for 1940 list 2 805 esophageal cancers (3 9 per cent) and 26 133 gastric cancers (35 9 per cent)

(Beginning in 1937 deaths from some causes in the United States have been tabulated according to the patient s residence rather than the place of his death)

During a five year period (1940–1944) the average death rate from gastric cancer in men and women was a little more than 26 000 per year, whereas the death rate from all varieties of cancer per year was 129 in 100,000 or approximately 171 000 each year

The relationship of mortality from gastric cancer to other death producing diseases should be kept in mind The number of deaths from heart disease for example every year in the United States is approximately 400 000 or 316 people in 100 000 It is important therefore that the number of deaths resulting from gastric cancer in proper proportion to other causes of death be a matter of continued study

By 1941 the mortality rate from all cancers was clearly higher in the Northeast East North Central and Pacific regions The South and the rural plains and mountain states of the West North and South Central regions showed lower rates

In the first eleven months of this country s participation in World War II the total war casualties for the United States in killed wounded and missing were about 47 000 during the same period in the United States about 47 000 persons died of gastric cancer[27]

The United States Public Health Reports [9] stated that

> Cancer attacks more people in the South than in any other region of the country relative to the size of the population involved The number of new cases per 100 000 population per year is nearly 50 per cent higher in the South than in the North among white males and nearly 40 per cent higher among white women The incidence rates in the West are intermediate between those of the North and South For the colored population the incidence rates are also higher in the South than in the North among women but the opposite is true for males Cancer of the digestive tract with the exception of the mouth liver and pancreas is relatively more prevalent in the North and less prevalent in the South More than one half of the deaths from cancer of white males in the North and West and 43 per cent in the South are attributed to cancer of the digestive organ

At the Montefiore Hospital (N Y C) from 1920 to 1945 inclusive there were 7 164 autopsies including 1 172 cancers of the gastrointestinal tract—392 of these were gastric cancer The ratio of men to women was 2 5 1 Gastric cancer thus made up 14 3 per cent of all cancers and 33 per cent of cancer of the gastrointestinal tract

It was predicted that in 1950 there would be 203 000 such deaths and in 1960 270 000 and it is estimated that by 1980 40 per cent of the population of the United States will be over 45 years of age The incidence of this disease in all probability, will continue to rise as the number of people in the older age group increases further

CHAPTER IV

Etiology

The exact etiology is obscure

Age Age, as already indicated, is an important factor in the etiology of cancer in middle or advanced age, however it occurs not infrequently in young persons

Of 2 038 patients examined by Welch many years ago with reference to age and cancer of the stomach 75 per cent occurred between the fortieth and seventieth years 24 5 per cent between forty and fifty years, 30 4 per cent between fifty and sixty years and 2 8 per cent before the thirtieth year

In 1 609 cases the data collected by Osler and McCrae[79] showed 2 5 per cent developed before thirty years of age

Social Status Cramer (1937) found that cancer of the stomach occurs predominantly in people in the lower economic levels Its development may be occasioned he believed by faulty alimentary hygiene

Race Cancer occurs in the white race twice as frequently as in the colored race

Congenital Factors Abnormalities Congenital abnormalities in the structure of the stomach are the soils which produce a small proportion of gastric cancers Among these abnormalities are misplaced fragments of embryonic gastric or intestinal mucosa, resting ' usually in the mucosa or submucosa Tissue or cell rests of the pancreas and adrenals are also found in this category

Heredity There are recurrent hypotheses, advanced with patient optimism, concerning the genetics of gastric cancer in man and animals There are, however some indications that heredity has important influence Man in a sense may be a prisoner of his parentage

Welch analysed 1 744 cases and found that a family history of cancer was present in about 14 per cent of afflicted persons

Many clinicians are in accord that certain families show a strong predisposition toward the development of gastric cancer but that such families are relatively rare in proportion to the total population

As in other varieties of cancer there are unusual families known for their high incidence of the gastric variety The family of Napoleon is an example The Little Corporal his father and grandfather, all three sisters and one of four brothers it is recorded died of gastric cancer (Napoleon himself died of a ruptured cancerous ulcer with abdominal metastases)

Von Verschuer and Kober[30] studied the genesis of cancer in 188 pairs of twins They concluded that there was sufficient evidence of hereditary influence on *localization* of the tumor but none for *general predisposition* Again in regard to gastric cancer this factor for localization was evident in data for identical twins as compared with fraternal twins

Macklin[31] in a study of tumors in monozygotic and dizygotic twins reached the following conclusions

More common are tumors which develop in both members of monozygous twins as compared with dizygous twins the tumor is of the same kind and in the same organ more frequently and the age of onset is more nearly the same Since monozygous twins have identical hereditary potentialities and dizygous twins do not these three facts support the belief that heredity plays an important role in tumor production site of occurrence and age of onset

McFarland and Meade[32] collected data concerning a series of 40 tumors occurring symmetrically and simultaneously in 20 pairs of monozygotic twins equally divided between benign and malignant growths They also reported the simultaneous occurrence of gastric cancer in uniovular twins who were 70 years of age

The proponents of the heredity theory argue that it is not an illogical assumption that there is a tissue susceptibility toward malignancy in late life when one considers the frequent transmission of such familial traits as early graying of hair presbyopia and certain degenerative skin changes

Trauma There is no proof that abdominal trauma is in any way responsible for the development of gastric cancer

Occupation Nothing definite in this regard has been established

Diet Absorbing studies of the relation of diet to gastric cancer in man are those of Linott Herbert and Bruske[33] They compared a large group in Holland with a similar group in England The incidence of gastric cancer in Holland was about twice that in England The diet of Hollanders contained a large amount of bread cheese and vegetables and a smaller amount of meat The food was taken at a higher temperature than in England and the consumption of spices spirits and tobacco was higher

There are contrary views on the subject of dietary influence in gastric cancer as there are concerning other presumed factors

Harnett s survey (1947) of 1400 cases showed no apparent etiologic influence either of diet or oral sepsis

Hormones No definite evidence has been found that hormones are factors in gastric cancer The main assumption that hormonal influence may be of significance in the disease was based on the fact that it occurs more often in men than in women Then again there are proved data that the endocrine system variously affects the function of the stomach which may or may not be directly related to cancer

It is commonly known among physicians that in women suffering from peptic ulcer there is a remission of symptoms during pregnancy A high incidence of histamine fast achlorhydria has been reported in pregnant women

The great majority of patients with gastric cancer are as previously noted men over 50 years of age This had led to the hypothesis that there is a definite relationship between sex hormonal control of the gastric mucosa and gastric pathology, including neoplastic changes

One of the basic discoveries in the entire field of cancer research is that certain chemical and physical agents are productive of cancer when brought in contact with living tissue The agents by means of which cancer can be induced experimentally

are divisible into two main groups (a) chemical and physical including hormones and (b) viruses

Of all natural and synthetic hormones only one group has to date proved to be carcinogenic—the estrogens

All estrogens have carcinogenic properties although their potencies vary With few exceptions their effect is limited to those tissues which they normally influence e g, the mammary gland and the uterus

It has been shown that changes caused by abnormality of endocrine glands are functional in character Hyperthyroidism, for example causes either hypochlorhydria or achlorhydria Repeated injections of solution of posterior pituitary produce ulceration of the gastric mucosa[34] In rabbits this induced lesion is manifested by intense engorgement and hemorrhage of the mucosa followed by acute necrosis of the acid bearing area of the mucosa in its entirety, with complete degeneration in about ten days In a certain percentage of patients a chronic punched out ulcer results

It is known that in some mammals continued estrogen treatment produces precancerous lesions of the accessory genitalia Significant in this regard was the report of Gardner and coworkers[35], indicating that cervical cancers were induced in 20 mice after prolonged stimulation with large doses of estrogen Pieces of these tumors transplanted to male and female mice continued to grow The hosts received no estrogen thus validating the diagnosis of induced cancer

Zondek[36] after a dosage of 6,000 000 I U of estradiol benzoate in three women over periods up to one year found cervical erosions but no evidence of malignant change

It appears that estrogenic power sufficient to produce cancer is related not only to the dosage but preeminently so to inherent tissue predisposition to malignancy

Loeb[37] summed up the matter by writing that there are substances with estrogenic but no carcinogenic properties others with carcinogenic but not estrogenic activity and some possessing both kinds of activity

> Estrin causes cancer formation in certain tissues because it acts as a specific and very potent growth stimulus and that its chemical relationship to some carcinogenic hydrocarbons is not the essential factor in this respect It is probable that specific growth stimuli acting over a long period of time ultimately change the cell equilibrium in such a way that certain substances inducing cell proliferation are propagated in an auto catalytic manner The essential factor in the cancerous formation is the action of the growth stimuli in cooperation with hereditary and constitutional factors [38]

Lacassagne produced mammary cancer in male mice which usually are not susceptible to the disease by the injection of large doses of an estrogenic hormone

Gastritis The prevailing belief today among many clinicians is that three gastric diseases namely gastric ulcer gastritis and benign tumor, may be regarded as precancerous lesions

Modern statistics seem to prove that patients suffering from chronic gastritis are three times more prone to gastric cancer than healthy persons

Chronic gastritis is commonly present in the adult stomach that shows no other lesions and inflammation is so frequently concurrent with cancer in various parts of the body that some investigators doubt that these lesions are precancerous ones

The detailed studies of Hebbel[39] indicate that chronic gastritis occurs so commonly in people past middle life without accompanying gastric cancer as in those with gastric malignancy

In an investigation by Nathan Shapiro *et al* [40] it was found that

> Thirty five cases of gastric cancer were selected from a group of 60 proved cases as satisfactory for clinico pathology study Microscopic evidence of atrophic gastritis was found in 28 of the 35 (an incidence of 80 per cent) The frequent co-existence of the two diseases strongly suggest a relationship the nature of which has yet to be determined

The incidence of atrophic gastritis is highest in the cancer age and great atrophic changes are frequently found in a stomach which is already the site of cancerous change

It appears that the gastritis is *not* secondary to the cancer There is a close etiologic relationship

Medical opinion is divergent between those who (Konjetzny Faber and Hurst) believe that 80 to 90 per cent of gastric cancers are induced by gastritis and others like Borrmann (1926) who wrote that in early cancer he had almost never seen a gastritis of severe degree

Although atrophic gastritis may involve the stomach in its entirety it is usually most obvious in its upper parts Microscopically three features characterize beginning atrophy namely (a) compression of the neck of gastric glands by inflammatory exudate with formation of retention cysts (b) cellular infiltration directly above the muscularis mucosae and gradual destruction of the base of the glands (c) prolifera tion of the pits

In general it may be stated that chronic atrophic gastritis is a definite and signifi cant precursor of gastric cancer

Pernicious Anemia In 1876 Quincke first mentioned the concurrence of pernicious anemia and gastric cancer in the same patient In the following year Fenwick origi nally described the pathologic changes in the stomach of persons suffering from per nicious anemia This was soon confirmed

The nature of the relationship was obscure Among many hypotheses three appeared as reasonable namely (a) pernicious anemia directly induces a precancerous state in the stomach (b) gastric cancer causes pernicious anemia (c) the two diseases are associated through a precursor or manifestation common to both

Rigler and Fink[41] have well summarized the known facts as follows

> 1 There is a distinct relationship between cancer of the stomach and pernicious anemia which is more than coincidental
>
> 2 The relationship may well be on the basis of atrophic gastriti which is a predi posing factor to both diseases
>
> 3 Cancer of the stomach hould be u pected in patients with pernicious anemia if the slightest gastric ymptom are exhibited

Rigler[42] and his associates found the incidence of gastric cancer in patients with pernicious anemia to be three times that of a controlled group

Magnus and Ungley[43] pointed out that gastric atrophy in pernicious anemia is not patchy as in most idiopathic achlorhydrias but is diffuse and moreover involves all the layers of the gastric wall especially the corpus and fundus resulting in a parch ment like tenuity of the stomach

The consensus among clinicians is that more patients afflicted with pernicious anemia eventually succumb to gastric cancer because of their increased life expectancy following the introduction of liver therapy

(It should be emphasized that the anemia which is concurrent with and often subsequent to development of gastric cancer should not be mistaken for pernicious anemia)

There is also a moderately high incidence of benign gastric tumors associated with pernicious anemia

Gastric Polyposis There is wide agreement that gastric polyps are precancerous growths Borrmann[44] Konjetzny[45] and Schindler[46] and others concur in this assumption

A dissident view is to the effect that when one considers for example, the high incidence of polypoid hyperplasia in ulcerative colitis it is found that cancerous change is extremely rare and that in all probability malignant degeneration of hyperplastic inflammatory tissue does not occur any more often in the stomach It is further argued that considering the rarity of gastritis with polypoid hyperplastic changes, the latter lesion cannot be an important precursor of gastric malignancy

Despite this contention gastric polyposis, though uncommon, is a precancerous lesion in a high percentage of patients

Benign Growths Grier Miller[47] has shown that gastric cancer may develop from a benign adenoma This tumor is a precancerous condition

Many other benign gastric tumors undoubtedly undergo malignant change, for example leiomyoma and neurolemmoma

Leo G Rigler[48] in a letter wrote that

> Obviously there are no absolute criteria histologic or otherwise to distinguish benign from malignant lesions We must therefore accept some standard of determination and at present histologic criteria are the most reliable On that basis it is certainly difficult to understand how anyone could say that a benign polyp of the stomach never becomes malignant
>
> This is not to say that all benign polyps become malignant From long experience we know that the majority do not But it is to say that every tumorous lesion of the stomach regardless of how innocent it may look roentgenologically gastroscopically or even histologically, should be considered as a possible progenitor of carcinoma if it is not already malignant

Gastric Ulcer A few years after Cruveilhier differentiated gastric ulcer from gastric cancer Rokitansky described a lesion which revealed the carcinomatous transformation of a benign ulcer

The relations of ulcer to cancer are still, as Ewing once said, 'rather close quite obscure and as yet incompletely explained '

There is no general agreement whether or not carcinomatous degeneration of gastric ulcers occurs Hinton[49] believed that gastric ulcer rarely becomes malignant and that if it is malignant it has been so from the beginning

Early cancer is often present in a so-called benign ulcer of many year s duration

> If a benign ulcer can become a malignant gastric lesion wrote Kaydin every patient with a gastric ulcer should be subjected to early operation I myself have become firmly convinced that the way to improve our present poor end results in the surgery of gastric cancer is to treat surgically what may be or may become a cancerous lesion The method is

used in the thyroid the mouth the breast the large bowel and many other sites Why we should be so reticent with lesions of the stomach is difficult to explain Therapy for a supposed gastric ulcer should not exceed five weeks after which any roentgenographic evidence of persistence of the ulcer is indication for operation [50]

There seems now however to be a tendency to underestimate the frequency of malignant change in peptic ulcers just as there was for many years a proclivity towards exaggerating it

In the ulcer versus cancer polemics physicians mainly differ on three grounds namely (a) That no benign ulcer ever becomes malignant and that the cancer is a distinct entity even when it is found at the site of a preexisting ulcer (b) that all benign gastric ulcers should be removed surgically because they ultimately become malignant (c) that certain unhealed ulcers become malignant especially with recrudescence while other benign ulcers heal some never to recur and others retain their benignancy even with recurrence

M J Stewart (1929–1931) found that ulcer-cancer occurs in just over 6 per cent of gastric ulcers This percentage appears to be low as would be expected from the ascertained facts that the most common site of gastric carcinoma is at the pyloric end of the stomach and that simple peptic ulcer is most commonly found on the lesser curvature

Estimations of the frequency with which ulcers undergo malignant change vary from 1 per cent (Borrmann) to 71 per cent (Wilson and MacCarthy[51])

A careful analysis of data available for a ten year period at the Massachusetts General Hospital showed that 14 per cent of patients treated as having benign gastric ulcer subsequently were proved to have cancer (Ann Surg v 114 p 498 1941)

Wangensteen[5] of the Mayo Clinic reported the frequent presence of malignant degeneration in gastric ulcers Most pathologists[53] believe however that the incidence of malignant degeneration of a benign gastric ulcer is approximaatelv 3 to 5 per cent

Sampson and Sosman[54] found that approximately *75 per cent* of prepyloric ulcers are malignant

(The first communication concerning a derangement of gastric secretion associated with carcinoma of the stomach is attributed to Bird [1842] who drew attention to the lack of acid or to the small quantity of free acid in the vomitus of patients with gastric carcinoma It has been suggested that the presence of cancer interferes with the secretion and others maintain that the cancer develops in a gastric mucous membrane which has been previously injured)

Gastric ulcer as aforesaid is generally considered to be a precursor of carcinoma but the evidence is inconclusive

Balfour found that of 195 patients who had died after treatment for gastric ulcer including surgical patients 75 (or 40 per cent) died of cancer of the stomach

Matthew Steward[55] estimated that 15 7 per cent of cancers arise in gastric ulcer and between 6 and 7 per cent of ulcers become cancerous

Konjetzny[56] and many other investigators maintained that gastric cancer never develops in a *normal* mucosa and that it results from chronic atrophic gastritis with hyperplasia The basic process is not the chronic inflammation but the regenerative change in the epithelium resulting from the chronic gastritis

It is held that there is little reason to believe that gastric cancer is dissimilar to

cancer in any other organ or tissue At the present time almost all clinicians are of the belief that cancer does not, as previously stated, take origin in a normal area and that in cancer there is definite evidence of chronic irritation It has never, *for example*, been doubted that cancer often begins in an ulcer of the tongue There is definitive evidence that cancer is likely to occur in any unhealed wound

In regard to the stomach in its entirety it has been substantiated that approximately 10 per cent of ulcers which presurgically are believed to be benign by the usual diagnostic methods are found to be cancerous when the ulcer is removed

The Sites of Gastric Ulcer and Gastric Cancer The site of an ulcer in the stomach is of greatest significance in regard to its possible malignancy Thus a chronic ulcer situated on or within half an inch of the greater curvature, even when it appears to be a benign one radiographically, should be suggestive of and treated as malignant Ulcers occurring at the inlet or outlet of the stomach are often malignant, while those found in the pyloric canal should be clearly suggestive because over 30 per cent are primarily malignant growths The *large* indolent penetrating ulcer, present on the posterior wall half an inch or more from the lesser curvature should usually be treated by incomplete gastrectomy because fully 20 per cent of these will reveal malignant changes when examined

(The larger the diameter of an ulcer the greater is the probability of its being malignant An ulcer crater, smooth in outline, projecting beyond the normal outline of the lumen with uninterrupted rugae convering toward it, favors the view that it is benign Many authorities contend that the size of the ulcer has nothing whatsoever to do with whether it is malignant or benign)

All benign growths of the stomach are liable to undergo malignant degeneration but this applies particularly to adenomas

Constant and intermittent trauma or irritation of the mucous membrane as may be induced by unsuitable articles of food, hot or iced drinks excessive use of tobacco and alcohol various proprietary medicines constant nervous tension avitaminosis severe chronic toxemias the effect of acute specific or infectious diseases or a congenital absence of free HCl in the gastric juice, have at times been suggestive of a predisposition to cancer of the stomach

Holmes and Hampton[57] and others have shown that ulceration of the stomach 2 cm contiguously proximal to the pylorus was prone to be malignant regardless of size of the lesion

In 90 per cent of patients the growth is in the pyloric half of the stomach It is found on the lesser curve in about 75 per cent and then in descending order of frequency in the posterior wall the pylorus the greater curve and the cardia

Welch many years ago analyzed 1200 cases with the following reported data pyloric area, 791 lesser curvature 148 cardia 104 posterior wall 68 greater curvature 34 anterior wall 30 fundus 19

The Mayo Clinic reported that of 10 per cent of lesser curvature ulcers 65 per cent are pre pyloric ulcers and *100 per cent of greater curvature* ulcers are malignant[58]

A survey of gastric cancer in London (Harnett 1947) reported the proportions of cancer at various sites the pyloric area 54 midgastric 33 cardia 13 per cent

(Mechanical friction is mostly at the pylorus where cancer is most frequent)

In the esophagus malignant change is most common at the three anatomic narrow

ings situated (a) at the upper end opposite the sixth cervical vertebra, (b) opposite the fifth dorsal vertebra where the esophagus is crossed by the left bronchus at the diaphragmatic hiatus About 40 to 50 per cent of cancers take root at the level of the fifth thoracic vertebra

(Cancer may develop in an esophageal diverticulum[59])

If the ulcer is in the antrum there is a 50 per cent chance of its being cancerous

No correlation is found between the site of the lesion of gastric cancer and production of free hydrochloric acid In general the gastritis in cancer of the stomach is a pangastritis Achlorhydria always precedes and is *not* a result of cancer

Cancerous Degeneration of a Benign Ulcer According to Newcomb[60] the signs of pre existent benign ulcer are

(a) Complete destruction of an area of muscle corresponding in size roughly to the floor of the ulcer (b) presence of a large area of dense fibrous and granulation tissue in the floor of the lesion (c) the presence of endo arteritis obliterans or thrombophlebitis in the vessels around (d) fusion or close approximation of the muscularis mucosae and muscularis at the margin of the ulc r All these points are usually but not invariably present in chronic peptic ulcers The only sign of benign ulcer never found in primary cancer is fusion of the muscularis mucosae and muscularis at the edge of the ulcer

Cancer invades muscle Ulcer destroys it

Indicative of the origin of a cancer is a circumspect examination of the gastric muscle to conclude whether the cancer grew on an ulcer with a destroyed area of muscle or on a stomach with muscle once normal and now merely invaded

It is only rarely that muscular tissue is noted on the base of a chronic ulcer and never in one of long standing

Pack wrote that in some parts of the body ulceration usually follows cancer—for example in epitheliomas of the lip tongue larynx and esophagus and in cancer of the colon and rectum There are examples in which ulcers precede the development of cancer such as in lupus scars burns and chronic sinusitis But in the stomach the moot question often propounded is whether or not a benign ulcer precedes the cancer

Eusterman[61] wrote that small ulcerating forms of gastric cancer are not only clinically indistinguishable sometimes from chronic benign ulcers but that they often respond to medical treatment so favorably as to give a misleading impression of their true nature

McVicar too called attention to the fact that an ulcerating lesion of the stomach which is apparently cured by medical treatment cannot always be assumed to be benign for even malignant ulcers often respond temporarily to medical treatment if they are not too far advanced (as quoted by Balfour[6])

The presence of a benign ulcer and an independent cancer in the same stomach is a rare occurrence

Viruses The sarcoma virus of chickens (Rous) the renal cancer virus of frogs (Lucke) and the skin cancer virus of cottontail rabbits (Schape) are well known to bacteriologists and clinicians

A great contribution to cancer research was made by Fabiger of Copenhagen who after years of careful investigation was able to prove that gastric cancer can be induced in certain species of rats by infestation with a nematode (spiroptera neoplastica) Cancer of this origin has no counterpart in the human being

Filterable viruses and various chemical carcinogenic agents are under investigations as potential causes of cancer

Bacilli It has been shown that if a stomach with an ulcer contains coliform bacilli or non hemolytic streptococci the ulcer is likely to be cancerous, for these organisms are seldom found in benign ulcers

Buccal Infection Many clinical observers have been impressed with the probable importance of buccal infection as a factor in the causation of gastric cancer

Neurofunctional Factors The classical case of Cushing started many experiments on the influence of the midbrain on the stomach The most extensive lesions obtained by destruction of tuber nuclei are superficial erosions

Experimental Gastric Tumors Epithelial tumors have been readily produced by the implantation of embryo stomach tissue together with olive oil containing methyl cholanthrene in adult mice of homologous strain The implanted tissue from the squamous part of the stomach rapidly encysted the oil and benign and malignant papillomas and squamous cell carcinomas soon appeared from the stratified squamous lining of the cysts

Cancer of the stomach has been extremely difficult to produce in laboratory animals and many lesions reported as malignant were actually inflammatory or hyperplastic It was not until 1942 that Stewart produced adenocarcinoma in the pyloric area of the stomach in mice by direct injection of methylcholanthrene in the wall of the stomach Strong in 1943 by subcutaneous injection of methylcholanthrene produced adenocarcinoma of the stomach in mice

Resume

The etiology of gastric cancer as of cancer elsewhere in the body is still mysterious The totality of evidence appears to indicate that cancer is not directly inherited (although a predisposition to it may be) that it is an acquired disease and that it is not infectious or contagious There are however many divergent opinions concerning the causative factors Among the leading debatable spheres is that of peptic ulcer versus gastric cancer

Certain evidence[63, 64] tends to show that gastric ulcers do *not* have a tendency to carcinomatous transformation As Hurst and Stewart[65] wrote 'The figures show that malignant disease develops no more often in a stomach in which there is a scar of a healed ulcer or even occasionally a still unhealed ulcer than in one from which an ulcer has been excised

CHAPTER V

Pathology

Esophageal Cancer

The tumor may be found in a part of the cervical or thoracic esophagus though the greatest number are found in the thoracic area

The rapidly progressive deterioration shown by patients with esophageal cancer indicates that the disease is highly malignant To a degree this is attributable to the obstructive character of the invasion which results in progressive starvation To a greater degree however the lethal character of the lesion is owing to its invasive tendencies and contiguity to vital structures

The three common sites of esophageal cancer are

(1) Mid third at level of tracheal bifurcation (50 per cent of patients)

(2) Lower third about the diaphragmatic level (25 per cent)

(3) Upper third about the level of the cricoid cartilage (25 per cent)

The records of the Breslau Pathologic Institution (1878–1900) for example furnished the following data 17 947 autopsies 1 674 showed cancer of which 204 were of the esophagus

Cervical esophagus	26
Thoracic inlet to the bifurcation of trachea	14
Level of hilus of lung	29
Between hilus and cardia	117
The whole esophagus involved	3
Site not recorded	18

Adenocarcinoma in rare instances is found in the lower third of the gullet It may arise from ectopic gastric mucosa or be an upward extension of a similar tumor of the cardiac end of the stomach

Varieties Cancer of the esophagus commonly a squamous-celled tumor and cancer of the cardia ordinarily an adenocarcinoma arising in the gastric mucosa differ in their histology rate of spread and direction Almost all malignant new growths of the esophagus are carcinomas

Seventy five to 90 per cent of esophageal neoplasms are as previously stated squamous celled cancers with cornification Of these squamous cancers many are undifferentiated or atypical without prickle cells or cell nests Transitional cell forms are present

The cardio esophageal junction is a favorable soil for the growth of multifarious cancers because of the presence there of several varieties of epithelium stratified squamous epithelium of the esophageal mucosa for example mucous epithelium of the free surface of the stomach and the gastric pits epithelium of the cardiac glands of the esophagus and the stomach and the epithelium of the ducts and secretory part of the esophageal glands

Cancers situated either at the lowest segment of the esophagus *or proximal part* of the stomach usually reveal the characteristics of the respective organs They are either (with exceptions) *epidermoid cancer* or adenocarcinoma The latter some times occur in the lower part of the esophagus, *seldom elsewhere*

There are, as previously noted two kinds of glandular elements in the esophagus —those which are found in the submucous layer and superficial glands ("cardiac glands") found in the lamina propria mucosae and prominent at the level of the cricoid cartilage These glands extend varying *distances into the stomach blending* gradually with the fundic glands

The esophageal glands are entirely mucous producing glands[68] formed by epithelial cells growing out from the surface epithelium through the muscularis mucosae in the form of ducts with subsequent glandular development in the submucosa These structures form at all levels of the esophagus varying greatly in number and distribution in different persons

Gross examination of esophageal cancers reveals the following forms

(a) An uncommon bulky polypoid projecting, or vegetative kind which usually grows into the lumen of the esophagus causing obstructive symptoms at a relatively early stage

(b) A shallow ulcerating variety causing early symptoms of mediastinal involvement The central part becomes necrotic and ulcerated thus for a time relieving the obstruction to some degree The tumor is more apt to extend for some distance in longitudinal growth There is a tendency to early perforation of the musculature and invasion of aorta, bronchi and trachea

(c) The hard infiltrating scirrhous kind which invades the esophageal wall and which may encircle the lumen causing fixation of the walls and producing symptoms *of obstruction It may be superficially ulcerative There is* first thickening of the esophageal wall forming a nodule or tubercle Each extension is in circumferential direction and later in the longitudinal one With its annular growth an extreme narrowing of the lumen consequently results with rapid production of a severe grade of obstruction The lining mucosa in this variety may show relatively little involvement for some time

The origin of the pure epidermoid cancers of the cardio esophageal junction has been attributed to the squamous cell epithelium of the esophagus

Concurrent Lesional Varieties Cancer of the esophagus is seen occasionally in association with benign lesions of the gullet—engrafted upon the dilated esophagus of cardiospasm for example

Cancer may involve the esophagus in a patient with esophageal hiatus hernia

That tuberculosis luetic and cancerous processes can be associated in a mixed lesion in the esophagus though rarely has been well authenticated

Metastases Malignant tumors of the esophagus tend to late metastasis and to spread up or down or around the esophageal wall infiltrating the wall but not early *involving the glands They soon invade and replace* the muscle coat and peri esophageal tissues When the glands pleura trachea or bronchus are involved the growth is inoperable

Esophageal cancer may produce widespread metastases and *nearly all organs* of

the body may be involved The lymph nodes are usually affected first those which are contiguous to the esophagus namely at the bifurcation of the trachea and along the lateral aspect of the gullet

Cancer in the middle third metastasizes to the first group and in the lower third to the second group The lymph nodes along the lesser curvature of the stomach and in the area of the coeliac axis artery are often involved when the tumor is situated in the lower third Usually cancer in the lower half of the esophagus is associated with some dilatation and extreme hypertrophy of that part of the esophagus immediately proximal to the lesion

In the upper third of the esophagus metastases may occur in the cervical lymph nodes

When the lesion involves the upper two thirds of the esophagus the secondary glandular deposits are found in the mediastinal parabronchial and deep cervical nodes

Metastases may be found in the lungs

Sarcoma of the Esophagus This is a very rare lesion

Gastric Cancer

Incidence The stomach is the commonest site for cancer

Site Statistical data appear to show the following percentages

Pylorus—60 per cent lesser curvature 10 to 15 per cent cardia 8 to 10 per cent posterior wall 5 per cent whole or extensive 5 per cent anterior wall greater curvature fundus rare (Ewing gave the percentage for the last named as 1 5)

The pyloric area especially the lesser curvature is thus the usual site The localized scirrhous or ulcerative variety ordinarily occupies this position The diffuse scirrhous variety (linitis plastica) is rare constituting less than 5 per cent

Varieties and Classifications All cancers of the stomach are of course glandular in origin but the degree to which glandular differentiation occurs in them varies greatly from lesion to lesion and also in different parts of one growth

Cancer of the stomach differs from cancer of other parts of the gastrointestinal tract in that the majority are less well differentiated and are therefore more malignant This is owing to the greater variety and function of epithelial cells found in the mucosa

Classification in the Recent Past The following varieties were usually described (1) simple adenocarcinoma (2) papillary adenocarcinoma (3) colloid or gelatinous carcinoma (4) medullary carcinoma (5) scirrhous carcinoma

1 Simple Adenocarcinoma This form it is assumed begins as a small elevated area occasioned by a proliferation of the gastric crypts The characteristic feature is the simulation of the gastric tubule which grows irregularly and projects through to the submucosa The edge becomes prominent and the center frequently depressed Necrosis and ulceration usually follow when the blood supply is cut off (figs 14 16)

2 Papillary Adenocarcinoma Malignant degeneration takes place owing to invasion of the stomach wall by the narrow stalk of the primary tumor The base of the growth widens in time The epithelial layer originally single or double becomes

multi layered The spread goes on through the basement membrane to the lym phatics of the submucosa Mucosal ulceration may result caused by obstruction to the blood supply (fig 17)

3 Colloid or Gelatinous Carcinoma This form is structurally an adenocarcinoma and is characterized by preponderance of the mucus producing cells These rapidly infiltrate the muscular layer and often metastasize to the regional glands and to the liver (fig 17)

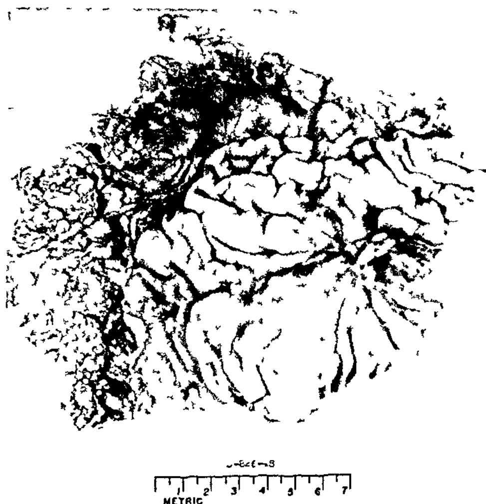


Fig 14 —Adenocarcinoma of stomach (Courtesy Armed Forces Institute of Pathology Washington D C)

4 Medullary Carcinoma The cells preponderate in this category The connective tissue is sparse The structure according to Ewing shows small or large alveoli or a diffuse growth of atypical cells Ulceration is common

5 Scirrhous Carcinoma In this category there are two forms—the circumscribed and diffuse (fig 18)

The first may grossly simulate ulcer in appearance This is a common variety of ulcerating cancer which resembles benign gastric ulcer roentgenographically This

tumor shows an excess of fibrous tissue with cancer cells appearing between the strands of connective tissue (fig 19)



Fig 15 —Carcinoma of stomach (Courtesy Armed Forces Institute of Pathology Washington D C)

Modern Classifications Steiner and Schindler[67, 68] believe the older classifications of cancer of the stomach inadequate because histologic varieties have not been properly correlated with degree of invasiveness rapidity of metastasis or prognosis Steiner maintains that today we are unaware of the variety of gastric cancer which develops from surface epithelium from the chief cells and from the parietal cells or other cells



Fig. 16.—Adenocarcinoma of stomach. (Courtesy Armed Forces Institute of Pathology and Washington Sanitarium, Washington, D. C.)

Schindler wrote that

> One may attempt to estimate the degree of malignancy of a gastric tumor according to the differentiation of the cancer cells. A tumor with a marked differentiation of cells with formation of tubules which look almost like those of a benign tumor may be called grade 1 cancer. If the tubules become more irregular, if their epithelium consists of several layers and if papillae are seen in their lumen, the tumor may be called grade 2 cancer. If the carcinoma is still able to form some tubules but consists mostly of coherent sheets of cells, it might be called a grade 3 cancer. If no formation of adenomatous tissue is seen and if the cells are of various sizes, the tumor may be called a grade 4 cancer.

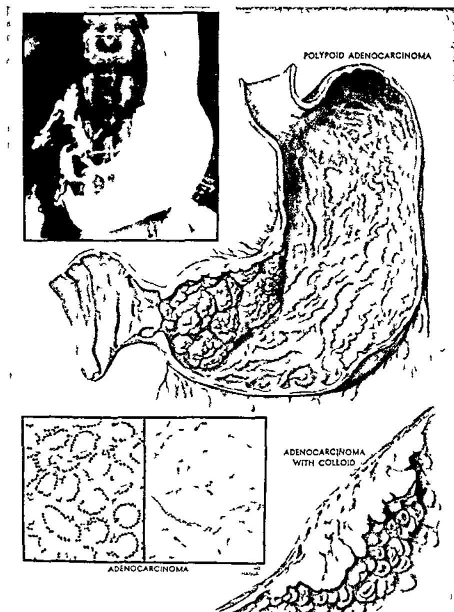


Fig 17 —Adenocarcinoma of the stomach Note typical polypoid or fungating appearance Size is no criterion for resectability (Courtesy The Ciba Collection of Medical Illustrations)

Schindler then quotes Livingston and Pack who

seem to believe that such a grading may permit one to a certain extent to make statements about the prognosis of a gastric cancer but I doubt whether it is true They contend that 60 per cent of patients having had a resection for a grade 1 or grade 2 cancer will survive operation for more than five years as compared with 20 per cent of all patients having had a resection

The microscopic type of a gastric cancer is less decisive for the final prognosis than its *macroscopic* character

Broders[69] classified cancer on the basis of the extent of differentiation of the cells in the growth He believed that this histologic feature was of prognostic value

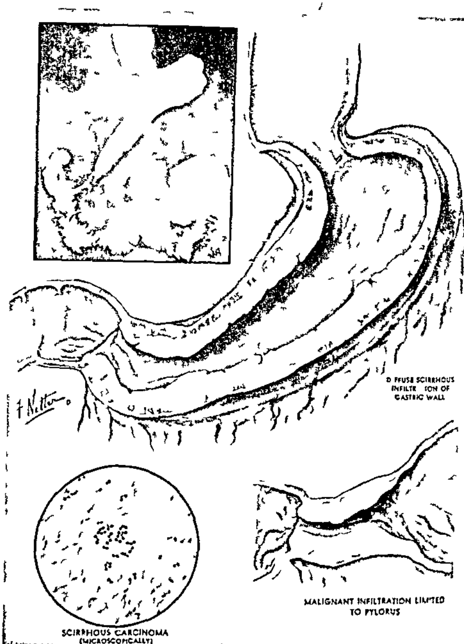


Fig 18 —Scirrhous carcinoma of stomach showing diffuse thickening of gastric wall of entire organ above and of pyloric region below (Courtesy The Ciba Collection of Medical Illustrations)

Borrmann *et al*[70] also maintained that the prognosis of gastric cancer cannot depend upon the microscopic structure of the growth but that an appraisal of the macroscopic character is definitely more decisive (fig 20)

Detailed Classifications Cancers of the stomach are usually classified according

to the tissue which is proliferating if this is glandular epithelium and if in proliferating the growth structure somewhat resembles glandular formation with acini

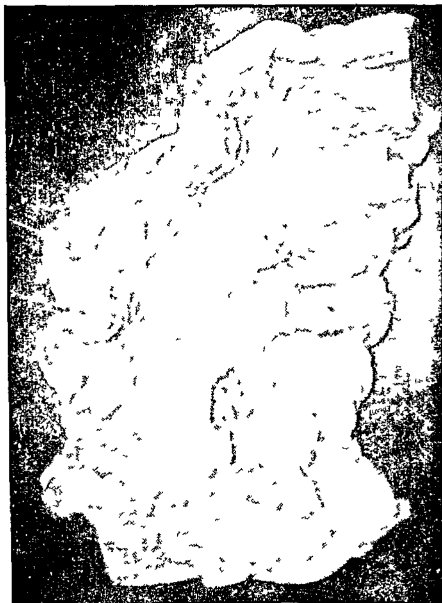


Fig 19—Medullary carcinoma grade IV Age 26 Roentgenogram showed filling defect along lesser curvature Gross specimen showed deep ulcer hemorrhagic base Microscopic examination revealed tumor cells proliferating in sheets (Courtesy *Color Atlas of Pathology* U S Naval Medical School J B Lippincott Co)

tubules and so on it is an *adenocarcinoma* others with undifferentiated cells are usually called cancer simplex or *spheroidal celled cancer* These cells tend to invade tissues in long columns of undifferentiated large cells closely packed and form the diffuse kind of cancer

A third variety is *colloid or gelatinous cancer*. This kind is also extremely malignant, characteristically forming nodules in the omentum and mesentery and *in the* abdomen in its entirety. This kind begins as an adenocarcinoma. The cells are

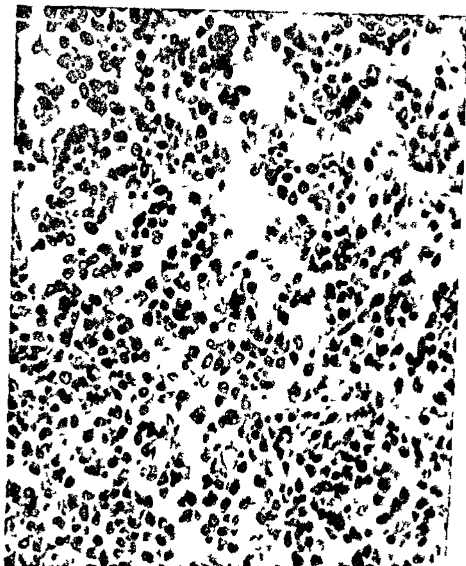


Fig 20.—Woman age 55. At necropsy the entire stomach showed neoplastic infiltration. Photomicrograph reveals small reticulum cells with dense nuclei and poorly staining cytoplasm. (Courtesy *Color Atlas of Pathology*, U. S. Naval Medical School, J. B. Lippincott Co.)

arranged in a formation as of irregular gland-like spaces full of degenerating cells surrounded by two or three layers of characteristic adenocarcinoma cells.

The fourth category—*scirrhous carcinoma*—is chiefly found at the pylorus and is slow growing, owing to the reaction of the tissues around the cancer cells, much fibrosis occurring, which limits the rate of growth. A special example of this is linitis

plastica This kind may persist for a considerable time without wide-spread involvement of glands

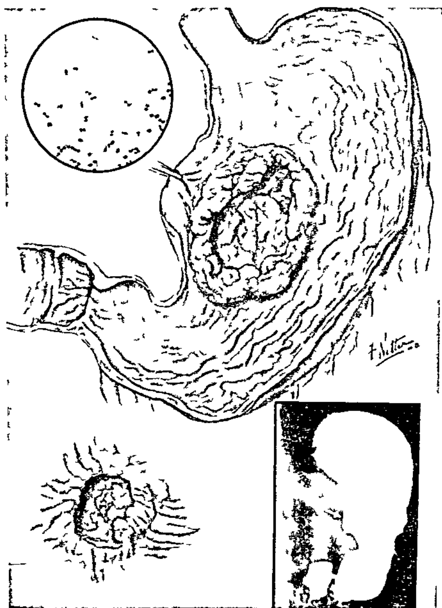


Fig 21 —Malignant ulceration of stomach (Courtesy The Ciba Collection of Medical Illustrations)

A fifth variety is the cancer engrafted upon a pre-existent peptic ulcer (fig 21) The history of this problem commenced with Cruveilhier [1] who was the first to distinguish clearly between chronic ulcer and cancer both clinically and pathologically

A few years later (1842) Rokitansky stated that cancer sometimes occurred with a single ulcer and that it might arise from the ulcer

Arthur Purdy Stout[7] furnishes the following succinct classification of cancers of the stomach

1 Fungating grows into the lumen and produces a mass It invades the deeper layers slowly and metastasizes late
2 Spreading grows along the wall and produces no mass
   (a) Superficial spreads in the mucosa and submucosa
      (1) Ulcerating
      (2) *Non ulcerating*
   (b) Linitis plastica spreads in the submucosa muscle coat and subserosa
3 Penetrating grows through the wall to the serosa and destroys and replaces the muscle
4 Unclassifiable advanced growths '

A classification in regard to direction of growth may be summarized as follows

1 Those that form vegetative or fungating masses with a tendency to grow more into the lumen of the stomach than to infiltrate the coats or undergo ulceration

2 Those that grow both into the lumen and into the wall of the stomach with extreme ulceration

3 *Those that grow and infiltrate the coats of the stomach rather than into the* lumen and have less tendency to ulcerate

All these varieties both grow toward the lumen and involve the coats of the stomach but some the less malignant and less rapidly growing tend to fungate, while others tend to ulcerate as growth progresses and still others the ' most malignant tend to infiltrate rather than form masses or to ulcerate (fig 22)

According to Shanks[3] the radiographic classification of cancer of the stomach falls into the following categories

1 Scirrhous
   (a) Localized
   (b) Diffuse
2 Encephaloid or fungous
3 Malignant ulcer

It must be stressed that malignant tumors have two basic growth characteristics (1) mass productive (2) invasive or infiltrative In some tumors one of these two qualities may predominate

Gastric cancer arises from mucus secreting cells few if any arise from parietal or chief cells (Rarely cancer arises from heterotopic pancreatic tissue)

William A Meissner[4] in a series of 200 stomachs surgically resected for gastric carcinoma or peptic ulcer of the stomach or duodenum found that

> The number of parietal cells diminishes as the pylorus is approached and is somewhat less along the lesser curvature than in corresponding areas on the wall of greater curvature The only quantitative change of significance was that in many cases of *cancer there* was a diminution of the number of parietal cells in the body and the fundus of the stomach whereas in cases of peptic ulcer especially cases of duodenal ulcer such a diminution was less frequent



Fig 22—Male age 33 Semicircular filling in lesser curvature Almost entire width of stomach encircled by a malignant ulcer Microscopic examination revealed an adenocarcinoma Note giant irregular glandular elements with hyperchromatic nuclei (Courtesy *Color Atlas of Pathology* U S Naval Medical School J B Lippincott Co)

A reduction of the number of parietal cell was not a constant finding in cases of cancer of the stomach in many cases of cancer and complete anacidity there was an abundance of parietal cells No stomach showed complete absence of such cell (See figure 23)

The gross appearance depends mainly upon the degree of growth discovered at the time of examination In general surgical specimens are less advanced and more informative for determining anatomic varieties than necropsy material

Early examples usually appear as ulcerating adenocarcinoma or scirrhous carcinoma In advanced stages of any variety the walls of the stomach are usually extensively infiltrated

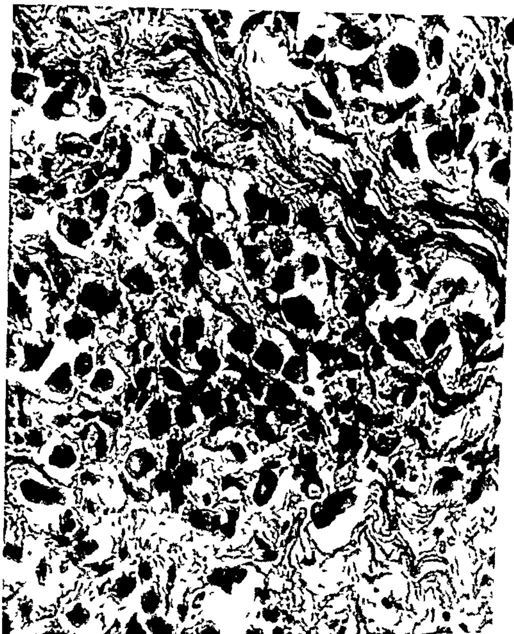


Fig 23 —Carcinoma of stomach (microscopic study) (Courtesy Armed Forces Institute of Pathology Washington D C)

According to Stout[75]

When cancer of the stomach starts from one or more focal points it does not spread at an even rate of spread in all directions Instead most of the tumors expend their chief growth energies in one or another of three different planes This accounts for their varying morphologic features Thus the fungating carcinomas include those which grow chiefly into the lumen the ulcer cancers on the other hand from the first penetrate through the gastric wall before they spread into other planes and finally there is a third group in which extension is chiefly centrifugal along the plane of the gastric wall These include the very rare linitis plastica cancers and the much commoner carcinomas which confine themselves to the mucosa and submucosa for a long time before they invade the muscularis

Superficial spreading cancer begins in and grows along the mucosa The malig nant growth replacing the mucous membrane usually obliterates the mucosal folds and flattens the surface In the circumjacent areas the mucosal folds radiate toward the cancer whether or not ulceration occurs and reach the margin of the involved



Fig 24—Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

area The malignant disease usually penetrates through the muscularis mucosae into the submucosa At times it is limited solely to the mucous membrane (figs 24-27)

In the most advanced examples malignant cells penetrate between the muscle bundles of the tunica muscularis and sometimes reach the serosa but the muscle is

not destroyed or replaced by malignant tissue This is in contrast to the penetrating variety which does destroy and replace muscle

Cancer at the pyloric orifice induces a ring like infiltration of the mucous and submucous layers and thus produces a stenosis which leads to dilatation and muscular



Fig 25 —Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

hypertrophy of the organ with stagnation of food and consequently fermentation The fermentation is aided by alterations in normal secretions especially deficiency or absence of HCl and growth of various bacteria yeasts and torulae

Ulceration of the inner surface of the tumor and hemorrhage are as a rule later manifestations (figs 28–33)

Bulky Adenocarcinoma This is the proliferative form and produces large cauli

flower or polypoid masses It is often a malignant mutation in an antecedent adenoma a sharply limited growth—mushroom like—with overhanging edges its surface presenting multiform nodes and nodules

The tumor is a columnar celled or cuboidal celled carcinoma revealing extreme tubular formation



Fig 26—Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

The tumors may be multiple and in some examples the lesion is concurrent with adenomatosis of the colon

Ulceration occurs late but even then the ulcer has a massive indurated over hanging edge As the tumor progresses the ulcerated area becomes larger and the walls of the stomach extensively infiltrated Occasionally the growth spreads super

ficially over the mucous membrane Sometimes soft bulky masses of tumor tissue (medullary carcinoma) project into the lumen of the stomach In advanced examples the growth is often partly ulcerative adenocarcinoma and partly scirrhous



Fig 27 —Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

Sometimes adenocarcinomas consist in part or entirely of a soft gelatinous slimy growth (gelatinous carcinoma) which on microscopic examination shows large amounts of intercellular mucin

Because polypoid cancer of the stomach tends to grow within the lumen and is at times circumscribed there is much less involvement of the muscularis

Colloid Carcinoma Colloid carcinomas begin in the secreting cells of the mucosa The gelatinous changes characteristic of this variety may occur to some extent in

any gastric cancer but in this variety it is the salient feature The wall of the stomach in its entirety may be infiltrated with colloid material and greatly thickened The growth forms an obvious tumor At a later stage translucent nodules are found scattered throughout the peritoneal aspect of the stomach



Fig 28—Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

Glands are not involved early in this kind of growth

The tumor it must be stressed grows inward and not outwards and in consequence is surgically inoperable before symptoms are far advanced

Ulceration and bleeding are not common in the colloid kind of tumor

Ulcer Cancer The malignant ulcer of the stomach occurs in most examples as a primary lesion in an apparently normal stomach The ulcer is the central part of a

large tumor which infiltrates all the *coats* and involves the peritoneal surface On inspection there is evidence of a *pre-existent* chronic gastric ulcer (A like lesion is at times found *arising* at *the* stoma of a gastrojejunostomy) Similar ulcerated cancers are also *found* in examples where the presence of a chronic gastric ulcer



Fig 29 —Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

is presumed owing to the clinical history morbid anatomy of the specimen and histologic pattern

Ulceration of a growth may be so extreme that few malignant cells are residual and these may be scattered in small groups at the *edge* of the ulcer

The distortion and fibrosis and cellular infiltration associated with a benign ulcer, on the other hand may be very hard to differentiate from early malignant change

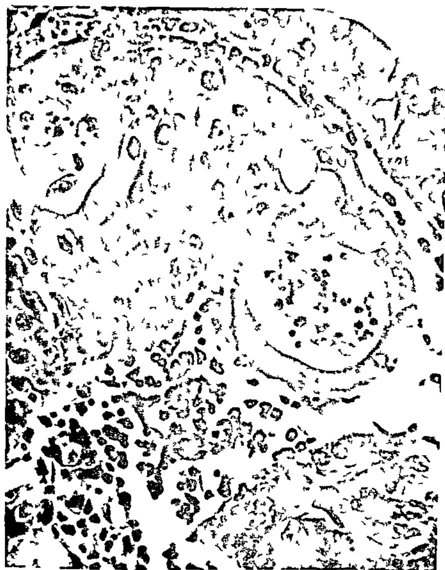


Fig 30 —Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

Medullary Cancer Ewing[76] describes the following two varieties

(a) Soft round ulcerating masses prone to hemorrhage and necrosis and spreading early to the other viscera and glands These growths consist of agglomeration of cells with little or no attempt at structure they occur often at the fundus and the cardia and are frequently radio sensitive

(b) Diffuse infiltrating lesions with widespread thickening of the stomach wall and only shallow ulceration

Scirrhous Carcinoma Localized Scirrhous According to Shanks[77] the filling defect of this kind of growth may be multifarious depending on the site and extent of the growth It may involve either curve solely or both The narrowing of the lumen may be slight or extreme It may involve a comparatively short segment of gastric

lumen or a large part "The transition from healthy to infiltrated stomach may be gradual or abrupt, so far as the lumen is concerned As a rule an abrupt stepping back of the barium shadow occurs at this point A common variety of filling defect is the napkin ring defect, as though the napkin ring were constricting the gastric



Fig 31 —Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

lumen The closer to the pylorus the narrower the constriction and those at or close to the pylorus commonly cause obstruction

Although these defects are so varied in shape they present certain common features namely

1 They remain constant in shape



Fig 32 —Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

2 They are aperistaltic The peristaltic waves can frequently be traced down to the upper limit of the filling defect then to disappear
3 They display a lessened flexibility when tested by radioscopic palpation
4 In contradistinction to the encephaloid variety these scirrhous filling-defects do not characteristically present any spiky or jagged outline
5 A palpable thickening or mass may be present

At the pylorus a small cancer may obstruct very early not only occasioned by the projection of the growth into the pyloric canal but because many cancers at the aforementioned site are of the scirrhous variety Cancer cells are few however tissue reaction is severe and there is much fibrosis in the thick pyloric muscle The pylorus is thus made inextensible and even if only one side of it is cancerous the whole pyloric ring is rigid and easily obstructed

The scirrhous cancers of the pylorus in spite of their placement in an area of complicated lymphatic drainage are often operable because the stenosis causes symptoms early and the glands in a scirrhous form of lesion tend to late involvement



Fig 33 —Squamous cell carcinoma of stomach (Courtesy Armed Forces Institute of Pathology and National Institute of Health Washington D C)

Diffuse Scirrhous Diffuse scirrhous cancer is not a very common variety It progresses more slowly than other kinds and involves glands earlier than adeno carcinoma or its colloid offspring

Sclerosing Carcinoma This lesion has been variously named in surgical literature for example cirrhotic gastritis, Brinton s disease fibromatosis ventriculi hyper trophic gastritis cirrhosis of the stomach gastric sclerosis

This group includes the local and the general varieties. There is characteristically a great thickening of the wall, of firm and even nature, produced by massive formation of fibrous tissue in which malignant cells are discoverable only after patient search. This constitutes a leather bottle stomach.

In the hour glass stomach a scirrhous cancer involves the pars media in an annular fashion. Characteristically the hour glass is X shaped in contradistinction to the B hour glass of simple ulceration. In the latter variety the contracture is solely at the greater curvature. In the hour glass form both curves are involved, the lesser to a less degree than the greater one.

Secondary esophageal dilatation is not uncommon in examples of scirrhous gastric cancer where considerable diminution of the lumen has taken place. The dilatation is caused by the reduced gastric capacity and not by gross obstruction.

Carcinoma Simplex. Here the relative proportion between the stroma and the cells is normal. The group has two characteristics: it ulcerates early and it invades surrounding tissues.

The stomach wall and circumjacent tissues are infiltrated with columns of malignant cells which show no alveolar structure. No leucocytic infiltration or fibrosis occurs around these columns to limit their growth. The cancer cells push the fasciculi of the stomach wall muscle aside, growing freely between them and not absorbing or destroying the muscle except at a subsequent stage.

These cancers are extremely malignant. Glands are soon involved.

The serous surface of the stomach is invaded early and contains either boss like projections of growth or seed like secondary deposits which are whitish and pucker the stomach's surface.

Multiple Carcinomas of the Stomach. These are rare. Diffuse chronic gastritis may be a precursor, especially when there is pronounced hyperplasia of mucous cells and multiple lesions of all grades of malignancy.

An example of multiple *dissimilar* cancers of the stomach was reported by R. L. Sanders[75]

Carcinomatous Perforation of the Stomach. As early as 1824 Laennec recorded the history of a patient with a fatal peritonitis resulting from a perforated gastric cancer.

Other complications of gastric cancer are pyloric stenosis, peri gastric abscess and gastric fistula.

Lesions Simulating Gastric Cancer. The close resemblance between peptic ulcer and ulcerated cancer and the fact that cancer may start in the margin of a peptic ulcer and that the two lesions may be concurrent in different parts of the same stomach have already been mentioned.

Exaggeration and irregularity of the mucosal folds owing to vitamin deficiency or gastritis may resemble cancer, especially if they are found in association with ulcers.

Hypertrophy of the pyloric muscle occurring in an adult and not associated with ulcer may, when palpated, at first feel like a tumor when the stomach is exposed.

Lymphosarcoma can most easily be mistaken for cancer.

Benign adenomatous polyps can be distinguished from fungating cancers because they do not infiltrate through the muscularis mucosae and are not associated with fibrosis.

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The fibrosis deformity and sometimes ulceration of the stomach associated with syphilis may also simulate cancer until microscopic examination proves its absence

A diffuse congenital cystic hyperplasia of the stomach simulating cancer was reported in the Bulletin of Johns Hopkins Hospital[79]

Carcinoid Tumors Oberndorfer (1907) used the term "carcinoid" because of his belief that the neoplasm was benign despite its resemblance to cancer Studies in recent years, however, have definitely shown that this tumor is not necessarily benign that local invasion of nodes occurs not infrequently with lesions at certain primary sites and that distant, widespread metastases are not rare[80, 81, 82, 83]

Carcinoid tumors were first described by Langhans in 1867 *Infrequent in the* stomach they arise from chrome cells near the basement membrane of the crypts of Lieberkuhn

Carcinoid tumors of the intestine (histologically like cancer) are benign or of low malignancy Common in the appendix, less frequent in other parts of the intestine they appear as small tumors in the mucosa and submucosa, of distinct yellow aspect owing to lipoid content

Secondary Carcinoma of the Stomach The pancreas is the most common offender Less commonly cancer of the colon, liver, gallbladder, lymph glands kidney, adrenal spleen, or retroperitoneal structures, may invade the stomach by contiguity during the late stages of the gastric cancer

Sarcoma of the Stomach The incidence is 1 per cent of all gastric tumors

The age incidence is rather earlier than that of cancer, beginning at 20 to 30 and occurring rarely after 70

The varieties of sarcoma of the stomach include fibrosarcoma or spindle cell sarcoma round cell sarcoma and lymphosarcoma Each tends to present a different roentgenographic picture

1 *Spindle-Celled Sarcoma* The incidence of this variety appears to be 36 per cent It tends to form a pedunculated subserous mass large enough to fill the abdomen and be mistaken for an ovarian tumor It may undergo cystic degeneration

2 *Round Celled Sarcoma* This form takes root in the submucous tissue and may be diffuse or localized forming a tumor mass which encroaches on the gastric lumen The tumor is most common in the pyloric half of the stomach is usually mistaken for an encephaloid cancer or polypoid growth *It forms 60 per cent of gastric sarcomas*

3 *Lymphosarcoma* This tumor tends to infiltrate the stomach widely *and to* produce diffuse thickening of its wall Frequently other parts of the alimentary canal such as the ileum and cecum are simultaneously involved The pyloric antrum is a common site but the pylorus itself is not usually affected The growth may show nodular or polypoid excrescences Obstruction is uncommon Kundrat's sign—swelling of the lymph nodes at the base of the tongue—in the presence of a palpable epigastric tumor is indicative of a lymphosarcoma

The radiographic features are varied *They are those of a filling-defect* rigidity of gastric wall and aperistalsis but there is nothing in these features which serves to distinguish the lesion from a cancer

A palpable epigastric tumor is common—more so than in gastric cancer

4 *Leiomyosarcoma of the Stomach* It is a rare intramural infiltrating variety which

resembles lymphosarcoma of the stomach The great majority fall into two groups endogastric and exogastric These two groups are somewhat similar pathologically although their sequelae are different In both the tumors tend to rise from the curvatures (Ewing) Balfour and McCann (1930) wrote that they take origin most commonly from the antrum rarely from the pylorus and never from the cardia

The pathologic picture is of immature muscle cells of different degrees of differentiation grouped into bundles and bands which are separated by a fibrous stroma Mitosis establishes the malignant nature of the lesion

Benign Tumors of the Stomach These are rare Pathologically they comprise three groups—connective tissue tumors glandular tumors and cysts

Connective Tissue Tumors Fibromas Fibromas may be either polypoid or intramural, more commonly the former in the pyloric area

Myomas and Fibromyomas These form the commonest variety in this group They may be pedunculated either subserous submucous or intramural

Angiomas and lipomas may also occur the latter tending to form large intragastric pedunculated tumors

Glandular Tumors In this category are the solitary and the multiple pedunculated adenomas The first form the commonest of gastric polypi which occur usually in the pyloric area and may reach the size of an apple

The multiple adenomas (syn multiple mucous polypi gastric polyposis) are spread uniformly over the gastric mucosa and rarely reach a larger size than cherries They are commonly found in conjunction with gastritis

Cysts These are rare and result from injury degeneration of tumors, implantation of hydatids or retention cysts in chronic gastritis

The hydatid cysts may reach large dimensions

Ulcer vs Cancer It must be recalled there are three varieties of chronic ulceration of the stomach namely benign chronic ulceration chronic ulceration with secondary carcinoma and primarily ulcerating cancers

The common sites of occurrence of chronic ulcer and of gastric cancer are not identical the latter being found more often at the pylorus and ulcer more frequent on the lesser curvature near the pylorus

In primary ulcerating gastric cancer the tumor occurs at more or less characteristic sites The consensus among surgeons appears to be that if an ulcer arises in the pre pyloric area there is 65 to 75 per cent chance that it is malignant Cancers are common in this area On the other hand although ulcers are infrequent on the greater curvature they are almost invariably carcinomatous in origin when present

Ulcers on the lesser curvature less than 2 5 cm in diameter are benign in 90 per cent of patients and malignant in 10 per cent however ulcers on the lesser curve larger than this size are usually malignant

(It must be emphasized that the muscle of the stomach as previously stated is destroyed by an ulcer but invaded and not necessarily destroyed by a cancer)

According to Portis and Jaffe[34] most gastric ulcers are discovered on the posterior wall near the lesser curvature in the area extending about three inches from the pylorus in the direction of the esophagus About 60 per cent of all gastric ulcers develop in the distal 6 cm of the stomach

Peptic ulcers are usually found where peptic activity and acidity are at the highest

level—namely, the pylorus and the duodenal area where the chyme is *residually* acid before admixture with the alkaline secretions of the liver and pancreas

In an ulcerating gastric cancer evidence that it arose from a previously benign chronic ulcer is given by

(a) Complete destruction of the muscle layers of the stomach on the base of *the ulcer*

(b) Fusion of the muscularis mucosa and muscle wall at the margin of the ulcer

(c) Intimal thickening of blood vessels

(d) The presence of cancer in only one part of the wall *and its absence on the* base of the ulcer and in other parts of the wall

Metastases It must be kept in mind that there are three systems of lymphatics of the stomach to wit the intra mural intermediary and the extra mural

The intra mural system comprises three networks the submucosal the inter muscular and the subserosal

The submucosal lymphatic channels communicate freely with similar ones through *out the submucosa and to a less degree with those of the duodenum* They also unite freely with the deeper intermuscular network through radial lymph channels

The intermuscular network is located between the oblique *circular and longi* tudinal muscle layers This network communicates with other similar channels as well as draining into the subserosal network beneath the serosal investment of the stomach

The intermediary system is made up of numerous small lymph channels between the subserosal network and the extra mural collecting systems

The extra mural system is comprised of four zones of lymphatic drainage cor *responding largely with the vascular supply of the stomach*

The first zone is the inferior gastric subpyloric, which consists of a group of nodes and lymphatic channels found in the gastrocolic ligament above and below the right gastroepiploic vessels This zone drains the lymph from the pyloric area of the greater curvature The direction of lymph flow is from above downward toward the pylorus and between the head of the pancreas and the second part of the duodenum These lymph channels and nodes accompany the gastroduodenal vessels Eventually they drain into the hepatic nodes along the *hepatic vessels and into the coeliac and* aortic nodes The majority of the nodes in this zone surround the outer aspect of *the gastroepiploic vessels often so much* as 3 to 4 cm from the greater curvature Radical removal of these glands must therefore include wide parts of the gastrocolic and duodenocolic ligaments Residual cancer is often found in this zone

The second zone or pancreaticolienal groups of glands drains the upper aspect of the cardia and fundus They are found in the gastrocolic and gastrolienal ligaments along the course of the left gastroepiploic vessels *Their efferent channels then drain* into the nodes along the splenic vessels resting along the superior aspect of the *pancreas Lymph nodes along* the short gastric vessels in the gastropancreatic ligament are occasionally the site of metastasis The efferent channels from the pancreatic nodes drain into the coeliac and aortic nodes

The third zone of lymphatic spread comprises the superior gastric *lymph nodes* and channels in the lesser omentum following the left gastric artery along the upper

two thirds of the lesser curvature This zone drains the lymph from the lesser curvature of the stomach except for a small area above the pylorus and the esophageal aspect of the fundus

The efferent channels from these nodes in the main drain to the coeliac nodes The nodes about the cardiac orifice drain somewhat to the esophageal nodes

The fourth zone includes the suprapyloric nodes which drain the lymph from the pylorus and the small part of the lesser curvature The efferent channels of these nodes drain to the hepatic nodes along the heptatic artery and here in turn to the coeliac and aortic nodes

Cancer emboli may metastasize in any one or all four zones of lymphatic spread

There are five proved means by which cancer extends beyond the limits of the stomach namely

(1) Direct extension or infiltration—involvement of contiguous structures
(2) Lymphatic embolism
(3) Lymphatic permeation
(4) Blood stream embolism to distant organs
(5) Transplantation (sedimentation) in the peritoneal cavity

Lymphatic Spread This is perhaps the commonest mode of spread in early cancer

The lymph node drainage from the cardiac end of the stomach may present considerable variations

In general it may be said that adenocarcinomas arising at the cardia spread peripherally below the diaphragm toward the gastrohepatic or gastrocolic lymph nodes depending upon the site of the tumor in relation to the greater or lesser curvature

It is commonly believed that cancer of the stomach does not extend beyond the pylorus into the duodenum but Castleman[5] demonstrated that duodenal involvement is rather high of 28 cases in which the tumor involved the pyloric end of the stomach he showed invasion in 7 patients It is therefore recommended that when a cancer arises in the pyloric area at least 3 cm of the duodenum be resected with it

The position and extent of glandular involvement is in part dependent upon the size position and nature of the growth but a large tumor may sometimes be present with little or no metastatic deposit in the glands while a small sessile tumor may be associated with widespread implants in the lymph glands Again in diffuse leather bottle stomach the lymph glands may not be involved or only at a late stage of the disease

The main line of spread in the stomach wall is upwards along the lesser curvature towards the cardiac end A growth of the pyloric part of the stomach *rarely* progresses into the duodenal bulb The growth spreads mainly in the submucous coat and in the infiltrating variety of cancer of the stomach such a spread is rapid and diffuse

Some surgeons contend that in contrast to the stomach the duodenum is rarely the seat of cancer and there is no relation between the incidence of the latter lesion and that of duodenal ulcer

The growth it is maintained usually arises in the second part at or close to the ampulla of Vater producing in addition to duodenal obstruction jaundice and symptoms of pancreatic disease

Spread from gastric cancer to the remainder of the bowel with the production of

areas of thickening and stenosis is known to occur infrequently Dixon and Stevens (Ann Surg v 103, p 263 1936) and others have reported examples

(There is a theory that the invasive character of cancers is in part the result of decreased cellular adhesiveness[86])

The growth may spread by way of the lymphatics to glands in the following situation (1) along the lesser curvature and around the left gastric artery, (2) behind the pylorus and on the head of the pancreas, (3) in the portal fissure or along the greater curvature and throughout the greater omentum (4) at the root of the neck on the left side (Virchow's gland) by way of the thoracic duct Spread may also take place to the umbilicus along the falciform ligament and to the recto vesical pouch and ovaries (Krukenberg tumors)

(Enlargement of the glands does not always imply malignant infiltration being often caused by infection from the ulcerated growth)

In the later stages metastases are common to the liver

In scirrhous growths of the pylorus the adjacent group of glands and even the lower coronary glands situated on the lesser curvature rapidly become involved

The lymph glandular involvement is least when the growth is situated on the anterior wall of the body of the stomach on the greater curvature or in the region of the fundus *The sessile ulcerating form metastasizes rapidly and extensively* whereas the cauliflower like growth and leather bottle stomach do not readily involve the regional lymph nodes and when they do their spread is more limited and less rapid

If the glands in the portal fissure become invaded with cancer they may press upon and occlude the bile passages giving rise to jaundice Growth occasionally spreads along the ligamentum teres to the umbilicus

Blood Stream Embolism When malignant cells enter the blood stream metastases occur in the liver lungs, pleura and bones under the skin as subcutaneous nodules or in other parts of the body

(A special example of blood borne metastasis of gastric cancer usually associated with the diffuse or leather bottle variety is the Krukenberg tumor—fibrosarcoma—of the ovary)

Peritoneal Sedimentation When cancer has reached the peritoneal surface of the stomach it is often indicative that the patient is inoperable because malignant cells are soon freely discharged into the general peritoneal cavity and give rise to carcinomatosis and tumors in the pelvis

Metastases in the omentum may cause such a thickening of the structure that it becomes palpable through the abdominal wall

Cutaneous Metastases Although cutaneous metastases may result from malignant lesions of various organs the majority arise from primary gastric cancer

CHAPTER VI

Symptomatology

Symptoms of Esophageal Cancer

The onset of esophageal cancer is insidious It is the most frequent cause of ob struction past the middle age period

The symptoms depend on various factors—site size progress and variety of growth contiguity to the stomach orifice recurrent laryngeal nerves the lower trachea left primary bronchus aortic arch carotid and subclavian arteries pleura and lung The symptoms are

1 Hoarseness
2 Dysphagia
3 Aphonia
4 Persistent irritating cough which may indicate involvement of the recurrent laryngeal nerves and paralysis of the vocal cords The cough often suggests pleural or pulmonary invasion
5 Involvement of the sympathetic chain this may give rise to Horner s syn drome—a constricted pupil with slight drooping of the upper eyelid enophthalmos and diminished sweating on the homolateral side of the face
6 Hiccough this may signify diaphragmatic involvement and that of the phrenic nerves

Painful impulses from the diaphragm pass over the phrenic nerves into the spinal cord by the cervical posterior roots descend in all probability by short pathways to the level of the second thoracic segment At that level a synapse with the cells in the anterolateral column occurs and the impulses pass out through the cervical eighth and thoracic first second third and fourth anterior roots to the cervical sympathetic chain Over efferent fibers the impulses are carried to the skin and other structures From the periphery the impulses then pass over the ordinary spinal sensory nerves into the spinal cord by the posterior roots (fig 33)

Dysphagia When the tumor is in the upper third of the esophagus the first symp tom may be dysphagia when in the middle third the first symptom usually is post prandial discomfort when the tumor is in the lower third the first symptom is often regurgitation of food

Dysphagia progressively increases At first solids then soft foods and finally (when spasm supervenes) liquids cannot be propelled into the stomach after passing the pharynx The patient experiences a choking sensation in an attempt to swallow solid food Sometimes after he has been transiently almost unable to swallow he may suddenly experience a sense of relief so that he can swallow again a small quan tity of liquid soft or solid diet This effect is consequent on a sloughing away of the central part of the growth so that there is a temporary restoration of continuity

along the lumen of the gullet (Thoroughly chewed food can pass through a slit as small as 5 mm in diameter)

Dysphagia is absent in the nonstenosing varieties of esophageal cancer

When the cervical esophagus is involved dysphagia is not uncommonly a late symptom because the malignancy is latent until there is fixation of a large enough component of the pliable esophageal wall to cause sufficient obstruction The esophagus as previously mentioned does not contain pain fibers The symptoms are consequently attributable to pressure on contiguous or adjacent organs and structures

From his subjective symptoms the patient is often enabled to localize the site of obstruction

Regurgitation Regurgitation occurring at first only at long intervals becomes more frequent and the patient finds that he obtains relief by inducing it voluntarily Then the successive intervals are shorter and finally regurgitation occurs at each meal even when only soft foods are taken The patient begins to chew his food with great circumspection and thoroughly, eats slowly and attempts to wash it down by drinking large amounts of fluid with each meal

Salivation Salivation comes on fairly early

Pain Pain is rarely present during the early stages of tumorous invasion It is more common in cancer that infiltrates the walls of the tube and in ulcerating ones than in the massive variety which grows intraluminally Persistent pain signifies extension beyond the esophagus proper when it may invade a blood vessel and cause severe bleeding

Esophageal pain is of two varieties The first is that which is caused by a local distension or muscle contraction directly above the level of the obstructing growth It is usually referred to the substernal area with radiation to the back and frequently to the neck The second kind of pain is a steady boring aching discomfort experienced deep within the thorax and in the back This is caused by periesophageal inflammation from a penetrating ulcerating lesion (This kind of pain usually indicates inoperability)

It is obvious from the foregoing that pain is dependent upon tension of the muscular esophageal wall Either distension or spasm may be an adequate cause The pain is commonly of a burning character when the cause acts continuously and of griping nature when it is intensely intermittent Pain consequently occurs more frequently when there is spasm associated with ulceration and in sudden distension of the tube (as by a foreign body) than in the presence of a slow growing cancer to which the esophagus gradually adjusts itself Ulceration per se is not painful The pain is influenced (as elsewhere in the body) by individual degrees of sensitivity and by changes in pain threshold of the same person

Persistent back pain in esophageal cancer fairly constant and dull, is usually localized to the left of the midline on a level with the eleventh or twelfth thoracic vertebra and is commonly not an early symptom It is mainly occasioned by extension of the growth to the body of the pancreas

Pain may be present even when the patient does not attempt to swallow

Weight Loss As the disease progresses the evidence of starvation is obvious

Anorexia occurs early and there is progressive loss of weight and strength dehydration anemia and cachexia In time certain signs may be present which are indicative of advanced disease aside from obvious ones, such as enlarged cervical lymph nodes pleural effusion etc

Anemia This is the one severe feature common to all of the afflicted persons

Tumor A palpable tumor is present in about 35 to 40 per cent of reported cases

Terminal Phase A terminal complication of cancer of the esophagus is rupture into one or more contiguous or adjacent structures or areas The lesion may perforate into the mediastinum trachea bronchus lung or even into the aorta or as previously stated other large blood vessels

Symptoms of Gastric Cancer

The development and character of the symptoms depend chiefly upon the site and variety of the growth the presence or absence of free HCl the size and extent of the cancer and its tendency to ulcerate bleed or metastasize

The lesion is so insidious that it is seldom suspected until it is far advanced This is particularly true of cancer of the fundus or body of the stomach or when the lesion is confined to the mucosa or submucosa The patient may become inoperable before there are any manifestations of the disease and amelioration may be possible at times when the lesion has been present for years

The duration of the pre symptomatic phase is not known it has been estimated that more than 50 per cent of gastric cancers metastasize during this period

No one symptom may be said to be always present or always absent As Moynihan said There are no symptoms pathognomonic of cancer of the stomach the symptoms are suggestive not conclusive

Almost any symptom referred to the abdomen may have its cause in cancer of the stomach

Patients suffering from gastric cancer may conveniently be placed in three groups namely (1) those who have never previously suffered from indigestion but who now complain of some slight symptom such as epigastric discomfort after partaking food flatulence or distension this may at first be relieved by alkalis or by dieting after weeks or months clear signs and symptoms are in evidence (2) there is a long history of indigestion which may or may not be of ulcer variety (3) relatively uncommon instances where a person becomes ill without suggestive symptoms of a gastric lesion

The subsequent development of the disease depends as previously mentioned, upon the *site* and *kind* of growth If the cardia or pylorus is involved there may be early obstructive signs evidenced by vomiting anorexia and loss of weight If there is ulceration and consequent infection especially if the HCl is low there will be signs of toxemia—lassitude and loss of appetite

Some of the polypoid adenocarcinomas may reach an enormous size before producing serious symptoms

The sign of Trousseau—thrombosis occurring in the veins of the leg—may arouse suspicion when an inconclusive diagnosis is made

The early symptoms then usually comprise (a) lassitude (b) loss of interest

(c) lack of energy, (d) mental apathy, (e) dislike of food, especially meat (f) nausea, (g) a vague feeling of discomfort after food, (h) mild but persistent dyspepsia, (i) flatulence (j) a feeling of weight in the abdomen, (k) *heartburn* (l) eructation

The British Empire Cancer Campaign's Survey of 1944 furnished the following data on analysis *of first* symptoms in over 1400 patients definite pain after food—24 7 *per cent* *definite pain with sudden onset—7 per cent* vague dyspeptic symptoms—22 per cent asthenia and anorexia—18 per *cent, no symptoms,* diagnosis made during operation—0 6 per cent

The late signs and symptoms may include regurgitation, vomiting constipation or diarrhea anorexia, loss of weight, emaciation, anemia, constant epigastric pain *not relieved by* food or vomiting, hematemesis dysphagia and symptoms of pyloric *obstruction*, cachexia, tumor (usually found anterior and to the *left of the median* line) appearing and disappearing alternately with respiration, *transmitted aortic pulsation*, slight rigidity of upper right rectus muscle, upward movement of umbilicus with liver (metastases)

Dysphagia is an early symptom with growths of the cardia and while it may be absent for a considerable time with growths situated elsewhere in the stomach it is usually present when the growth is advanced

There is usually some degree of lo s of appetite At first there is merely a disinclination for food at a later stage there is a definite dislike of or distaste for food especially meat, until finally there may even be an abhorrence of the very sight or thought of food

If the hepatic metastasis occurs jaundice and rapid emaciation develop A small *gland* or *glands* above the medial part of the left clavicle may be the first indication *of cancer of the stomach*

(Latent carcinoma of the stomach is occasionally found accidentally or post mortem without a history of previous symptoms)

In involvement of the body of the stomach, the patient may have an external growth and yet complain of very few symptoms because motor activity is not interfered with and the lesion rarely affects the cardiac or pyloric orifices Obstructive *symptoms are then absent the stomach emptying* at the normal rate or sometimes a little more rapidly than normal For this reason this area is called the silent area

In lesions around the pylorus the symptoms appear early as a rule and are owing to an incomplete obstruction which quickly attracts the patient's attention to the gastric disorder

Growths of the pylorus proper often small produce symptoms relatively early because they soon cause a greater or less degree of obstruction Occasionally the pyloric ring is completely infiltrated without obstructing the *lumen consequently there is a rigidly fixed open* pylorus through which on roentgenologic examination, it is noted that the barium streams quickly, thus emptying the stomach

Constipation (owing to lack of "bulk") is the *rule in the obstructive* variety while diarrhea frequently accompanies growth of the body of the stomach

Another kind of tumor begins at the pylorus it is not annular but invasive and frequently extends along the wall of the stomach *not always* producing obstruction

Nausea and vomiting may occur relatively early in the disease regardless of the site of the lesion but are much more frequent when the pylorus is obstructed

Cancer of the cardia and fundus may show but few signs or symptoms but if the contiguous area of the esophageal gastric junction is involved the symptoms are similar to those of esophageal obstruction

In the more rapidly growing cancers (medullary and colloid cancers for example) early ulceration with hemorrhage may be prominent features while on the contrary, the more slowly growing and firmer scirrhous cancers are not so easily discovered from their symptoms unless they exert mechanical interference with digestion

In gastric carcinoma weight may at times be retained in spite of the progress of the disease however the majority of patients lose weight rapidly and steadily especially where there is an obstructive variety of lesion This loss of weight is accompanied by weakness weariness and later cachexia

Loss of weight is owing to (1) complete or incomplete gastric stasis (2) chronic gastritis (3) anorexia (4) chronic toxemia (5) vomiting

Pain is of two kinds somatic and visceral Pain caused by involvement of nerves by the growth occurs in the epigastrium and back It is relentless and worsens progressively

Pain owing to the growth in the stomach may simulate gastric ulcer in being relieved by food and undergoing remissions but not for long periods It may be simple or persistent and relieved by vomiting It may occur early or late in the disease and occasionally be absent It is rarely severe until the cancer has ulcerated or invaded the wall of the stomach The distress may consist only in an indefinite sensation of fullness or burning in the epigastrium

The pain when mild amounts to little more than a sense of discomfort uneasiness upset fullness or of weight in the epigastrium Although distress is a common symptom severe pain at first is rare and is usually the result of extra gastric involvement from penetration or perforation by the growth

Pain in the main appears earlier and is more severe in patients with acid gastric secretion than in those with anacidity presumably because of inflammation and acid stimulation of exposed nerve fibers It seems the lower the pH of the gastric content the greater the tendency to early ulceration and pain

Gastric pain does not appear to be caused mainly by ulceration of the mucosa because such a process even to the degree of perforation sometimes occurs without pain The main cause of gastric pain appears to be tension in the wall of the viscus whether occasioned by passive distension or active spasm

There is evidence that pain impulses from the stomach enter the spinal cord at the seventh and eighth thoracic segments on both sides

Beattie[87] showed that stimulation of the tuber cinereum in animals caused increase in gastric tonus hypermotility and hypersecretion Cushing in his famous experimental work injected pituitrin and pilocarpine into the lateral ventricle in man and produced the aforesaid effects He reported a series of cases (1932) which proved that acute perforations of the stomach esophagus and duodenum were induced after operations on the brain for removal of tumors His evidence showed that a parasympathetic center is present in the hypothalamus which sends fibers to the

medullary vagus center He contended that injuries *to this diencephalo vagal* mechanism might induce erosions perforations or ulcers in the esophagus stomach or duodenum Masten *and Bunts*[93] *corroborated* Cushing's view The latter further suggested that the common occurrence of chronic gastric or duodenal ulcers in *high strung*, vagotonic persons may be owing to a disturbance in this supra segmental part of the parasympathetic system

Mackenzie[89], Ross[90], and Head[91] believed that in visceral disease a variety of irritation is produced in the spinal cord and that sensory impulses from other parts passing into this segment are so exaggerated as to be painful

It will be recalled it is only the efferent fibers of the autonomic *system proper* which are involved in the production of pain and such afferent fibers as travel along with it are *in the ordinary spinal sensory system*

The anemia in gastric cancer is not characteristic and variations from the macrocytic hyperchromic to the microcytic hypochromic disorders occur In most instances it is normochromic

According to Davies[9] failure of gastric secretion is progressive and involves HCl pepsin and intrinsic factor production in the sequence named so that, theoretically a patient suffering from cancer ventriculi may exhibit no anemia a micro or normocytic hypochromic anemia or a megalocytic anemia

Hematologists in the main, appear to be agreed that in patients with gastric cancer the anemia *when present* is hypochromic and either *micro* or normocytic although much less commonly megalocytic anemia may occur Many clinicians *maintain that when the last named is present the blood picture is indistinguishable* from that of pernicious anemia

Ulcer Change to Cancer In a person known to be suffering *from a chronic gastric* ulcer of some duration the following symptoms are suggestive of the possibility that the ulcer has become malignant

Loss of Periodicity of Attacks and of Symptoms With the onset of cancer there is absence of periodicity of the attacks and loss of regularity of daily painful episodes The present attack is characteristically different from the previous ones It appears to worsen progressively The interval too between the present attack and the *antecedent one is much shorter than the interval* between the earlier attacks

Character of Pain The character of the pain is also different It is mild but continuous and there is no longer the interval *of post prandial relief* The sharp burning ulcer pain is replaced by a dull ache which is intensified by eating When however the ulcer—benign or malignant—has eroded the pancreas pain is always severe continuous and frequently referred to the back or left shoulder area As a rule the severity of the pain is not such a significant feature of malignant degeneration as *the continuous* character of the pain

Anorexia Anorexia usually increases when a benign ulcer becomes transformed into a cancerous one

Nausea Nausea is ordinarily a common feature of malignant growths of the stomach

Vomiting While vomiting has previously given relief with the onset of cancer

this is not the case The vomiting of 'coffee grounds' is often seen with large fungating or necrotic growths

Loss of Weight At first this is slight but is progressive with the advance of the disease

Patients giving a short history may be grouped into two categories those with obstructive symptoms when a correct early diagnosis is often possible and those without obstructive symptoms when a diagnosis is commonly delayed

The severity of the symptoms is largely dependent upon the degree of obstruction present and therefore more upon the site of the growth than upon the actual size of the lesion

All the objective signs of cancer of the stomach—emaciation anemia tumor mass etc—appear at a late stage in the disease

Signs indicating that a carcinoma is already inoperable are

(1) Supraclavicular glands on left side
(2) Cancerous nodules in liver
(3) Secondaries felt by rectum
(4) More than one mass felt in abdomen
(5) Fixity of a mass felt in abdomen
(6) Dysphagia with mass felt in epigastrium
(7) Subcutaneous nodules of cancer
(8) Ascites
(9) Extensive involvement of glands
(10) Palpable carcinomatous omentum

TABLE 2—*Theoretical Clinicopathologic Correlation in Gastric Carcinoma*

Symptom	Gross	Microscopic	Grade of Malignancy
Dyspeptic	Bulky	Adenocarcinoma or adenomatoid carcinoma	Slowly growing
Ulcer	Ulcerative	Adenocarcinoma	Moderately rapid in growth
Cachetic	Infiltrating	Scirrhus carcinoma	Diffusely invasive

(Courtesy *Color Atlas of Pathology* U S Naval Medical School J B Lippincott Co)

Signs and Symptoms of Perforation of the Stomach A perforation of an ulcerating gastric cancer may be the first clinical manifestation of the disease

The signs and symptoms depend upon a number of factors the most *important* being the *length of time* which has elapsed since the perforation took place There are signs of (a) prostration (b) reaction (c) peritonitis

An acute exacerbation of the symptoms occurs in many patients before perforation occurs When perforations is imminent the patient is suddenly seized with an acute agonizing pain over the abdomen but is more intense in the epigastrium especially on the left side over the rupture site

Pain is usually constant sometimes being referred to both shoulders it is caused by irritation of the diaphragm and is referred through the phrenic nerve to the cutaneous distribution of the fourth cervical spinal segment

The temperature is nearly always subnormal The pulse is usually small weak and rapid Respirations are shallow and thoracic in character owing to the immobility and fixation of the diaphragm

The abdomen is retracted and immobile, there being no movement on respiration The muscles of the abdominal wall are tense and rigid—the rigidity extending to the flanks

CHAPTER VII

Diagnosis and Differential Diagnosis

I Esophageal Cancer

Physical Examination A careful history must be taken At first physical examination is usually negative or hardly suggestive although some loss of weight and pallor may be noticeable Slight tenderness or resistance may be elicited in the epigastrium Sometimes there is a slight epigastric prominence

Even a large growth mav be impalpable when the stomach lies collapsed or hidden under cover of the liver or ribs

Physical examination in late conditions leaves no doubt regarding the disease The patient is anemic lemon tinted or yellowish The eyes are sunken The face is drawn and the nose pinched

Enlarged supraclavicular glands a nodular liver or pelvic mass indicate that the growth is inoperable

A clinical examination is never complete without investigation of the areas in which secondary deposits may be discovered Thus the left supraclavicular fossa the liver peri umbilical area and especially the pelvic rectal pouch must always be carefully examined

The most striking feature of course is emaciation (The sallow appearance may be the first sign of the disease) Any unexplained anemia with or without digestive symptoms and wasting in a patient past middle age should immediately arouse suspicion of esophago gastric cancer

When the cervical esophagus is involved there is weakness or loss of voice

Not infrequently there is a fistula into the trachea or left bronchus or a peri esophageal abscess

While in an abdominal examination nothing abnormal may be noted or palpated the epigastric area is usually retracted and there is a dome like appearance of the lower abdomen There may be visible peristalsis (suggestive of obstruction) the waves coursing across the epigastrium from left to right The whole abdomen may be distended and tense with ascitic fluid

Epigastric tenderness and resistance are commonly present with a palpable tumor which is hard irregular and may be movable or fixed As the disease progresses enlargement of Virchow s glands subcutaneous nodules at the umbilicus a mass in Douglas s pouch irregular enlargement of the liver with jaundice distension of the abdomen with ascites or thrombosis in the leg may be evident

Swelling of the abdomen consequent upon ascites with or without jaundice from metastases to nodes in the portal fissure or occurrence of massive enlargement of the liver may be the reason for the sign

The suggestive symptoms of esophageal cancer were described in the antecedent chapter A point to bear in mind is concerning dysphagia It may sometimes be

intermittent owing to sloughing away of masses of growth or to the alternate impaction and dislodgement of unchewed solid food Another point to bear in mind is that pain is sometimes absent even in inoperable patients

It should be assumed, until disproved, that any patient forty years of age or over who complains of difficulty in swallowing is suffering from esophageal cancer

An unexplained phlebitis in a patient over fifty, especially if other thromboses occur elsewhere in the body, is sometimes evidence of gastric cancer

In the lower half of the stomach (including the duodenum) it is often possible to palpate a small cancer

(Tumors on the posterior wall of the stomach may be impalpable when the stomach is distended)

Roentgenographic Examination The introduction of radiology and endoscopy towards the end of last century made not only definite diagnoses of esophageal diseases possible but also development of esophageal surgery

Roentgenographic examination enables a clear distinction to be made between those growths which are constrictive and those in which little constriction is present but where there is a wide involvement of the esophageal wall

Fluoroscopic examination alone is not conclusive but of value with roentgenography Peristalsis is then observable, delay in normal swallowing time estimated and local spasmodic contraction seen

Photofluorography has its advocates in the diagnosis of early cancer of the esophagus and stomach

The esophagus is examined with the patient horizontal as well as erect Films are exposed at selected times with a spot film device In the horizontal position under normal conditions the barium bolus is propelled toward the stomach by active peristalsis showing flexibility of the walls After a swallow of fluid barium a thick barium paste should be used which adheres to the walls and thus permits study of the mucosal folds and other contours

At the lesional site under fluoroscopy the lumen is seen *constricted and eccentric The walls appear immovable* Their expansion and contraction are apparently lost Irregular filling defects are seen in place of the normal smooth mucosa The stream of barium may be deflected through a serpentine path and suddenly appear in an apparently normal lumen A soft tissue shadow denoting the thickness of the affected area may be visible above the growth The esophagus may be dilated Dilatation above a malignant constriction is usually slight or absent A little enlargement is occasionally found especially directly above the growth

Where there is an ulcer crater the barium may reveal in profile, a projecting crater The ulcer may be deep and punched out or somewhat shelving with marginal irregularity *Irregularity of margins of the strictured area favors the diagnosis of a malignant growth* The circumjacent esophageal wall is thickened It produces a filling defect within the lumen The descent of the barium is apparently not delayed

Where there is superficial ulceration the lumen is narrowed somewhat the margins are slightly irregular because the normal mucosal folds are absent

The degree of constriction obviously varies greatly in different patients It may be so slight as to be hardly detectable or completely obstructive Part of this obstruction is attributable in some examples to muscle spasm directly above the lesion

The growth ordinarily forms an angle where the constriction joins the flexible wall unless a sufficient degree has occurred above it to produce spasm

The esophagus it must be recalled may be invaded and obstructed by a metastatic or primary malignant mediastinal growth The differentiation from cancer of the esophagus may be impossible unless the history is suggestive or definite

Cancer of the middle third of the esophagus (usually just below the aorta) some times makes a conclusive diagnosis and differential diagnosis difficult In the early stages a small tumor may cause only a slight deviation of the barium stream and little interference with the flow The deviation is highly suggestive especially if it is tortuous (A traction or pulsion traction diverticulum may divert the stream and the barium residue may mimic an ulcer crater)

Cancer of the Lower End of the Esophagus This growth can be radiographically placed in four categories namely

(a) A large mass which obstructs the esophagus and produces an extensive irregular filling defect
(b) A constriction at the lower end of the esophagus with dilatation above thus resembling the pattern produced by cardiospasm
(c) The tumor is basically a gastric one and a bulky mass may be observable in the fundus of the stomach Infiltration of the lower end of the esophagus however causes it to lie characteristically horizontal
(d) Ulceration of a deep penetrating kind which may be erroneously diagnosed as peptic ulcer

Esophagoscopy Diagnostic esophagoscopy should be preceded by a roentgeno graphic examination of the tube Several days should elapse between the first and second examination

A new esophagoscope was devised by A Ray Hufford of Grand Rapids, Michigan It consists of a standard Jackson variety of esophagoscope with an inside diameter of 9 mm fitted with a flexible stainless steel spiral protruding six inches beyond the open end of the scope and tipped with a flexible pointed rubber finger such as is used in a flexible gastroscope The flexible spiral is attached to a solid metal base which fills the bevelled end of the scope This in turn is attached to a solid metal rod the length of the scope and meets a metal cork at the proximal end firmly securing the protruding flexible part during passage of the scope Once this is passed to the desired depth the flexible obturator is withdrawn and the optical tube of the Eder Flexi I gid gastroscope (encased in a metal sheath of about three quarters inch length of scope) is passed to the desired focal depth The metal sheath is re tained in situ through the examination secured by friction at the proximal end of the scope and by means of a small set screw which allows for adjustment of the optical tube to the proper focal distance and keeps it centered at all times

Indications for Esophagoscopy There is only one major indication for esopha goscopy—presumptive diagnosis of cancer

Examination by direct visualization yields three important kinds of information namely (a) the presence of an intrinsic lesion (b) biopsy is possible (c) a diagnosis can be established in regard to feasibility of surgical removal of the tumor

Contraindications to Esophagoscopy The following conditions if found on roent genographic examination constitute contraindications for esophagoscopy

(a) Acute laryngitis
(b) Laryngeal edema
(c) Obstruction directly below the constrictor muscle of the pharynx
(d) Pulsion diverticulum
(e) Aortic aneurysm if it compresses the esophagus
(f) Acute esophagitis

Esophagoscopy as it is usually practiced has certain inherent dangers and disadvantages

Most esophagoscopes are marked in centimeters of their length commencing at the distal end The length of the tube introduced can thus be measured against the level of the incisor teeth

The changes in direction of the esophagus must be borne in mind during esophagoscopy because the position of the head and neck must be altered to allow the progressing esophagoscope to point in the direction of the area under investigation

The movements of the esophagus consist of intrinsic ones of involuntary muscular contraction (as in swallowing and regurgitation) and of extrinsic or transmitted movements These are the pulsating movements from the aorta and lower down from the heart itself while the subatmospheric intrathoracic pressure causes the lumen of the esophagus to open during inspiration

It must be remembered that the esophagus is affected by any shift of the mediastinum owing to thoracic disease

The endoscopic landmarks consist of the upper and lower ends of the three intermediate narrowings The upper end is distinctive because of the presence of the sphincteric cricopharyngeus—a band of the lower fibers of the inferior constrictor muscle The muscle is attached laterally to the cricoid cartilage against the posterior wall of the hypo pharynx and thus closes the mouth of the esophagus The closure is tonic and constant The opening takes place in coordination with swallowing or vomiting

The lower end of the esophagus is also distinctive owing to the change from the smooth mucous membrane of the esophagus to the reddish gastric mucosal folds This level must not be mistaken for the diaphragmatic narrowing which is one or two inches above the junction of the esophagus with the stomach

The three narrowings of the esophagus are caused by

(a) The aorta and left bronchus which cross it anteriorly
(b) The diaphragm which constitutes a lower sphincter

The aortic narrowing varies in degree but if the mouth of the esophagoscope be directed against the left anterior wall of the esophagus the pulsations of the aorta are strongly felt

Directly below this area the left bronchus causes a slight backward displacement of the esophagus and the ridge caused thereby may be prominent, especially in elderly patients

Keith[93] maintained that a true esophageal sphincter is present in the wall of the esophagus at the level of the diaphragmatic hiatus but entirely independent of it

There is a fourth narrowing which is not observable during esophagoscopy It is at the level of the superior aperture of the thorax and is probably produced by the crowding together of the numerous structures which enter or leave the thorax

through this orifice Its importance lies in the fact that foreign bodies commonly lodge there

Patients who are to undergo esophagoscopy receive a complete medical examina tion This is important (aside from other reasons) to exclude any condition which may contraindicate the planned examination The mouth pharynx and larynx receive special attention

Anesthesia for Esophagoscopy Esophagoscopy may be carried out under local or general anesthesia It is possible to pass the esophagoscope without an anesthetic but this requires expert skill on the part of the operator and the close cooperation of the patient

When local analgesia is the method of choice a preliminary hypodermic injection of morphia (1/4 to 1/3 grain for adults) is given a half to one hour before the en doscopy This may be combined with atropine sulfate 1/100 grain to minimize secretion and to obtain reduced spasmodic effect

Immediately before the introduction of the esophagoscope the pharynx is sprayed with a 10 per cent solution of cocaine (The patient is previously tested for sensi tivity to the drug)

Anesthesia is unnecessary for the lumen of the esophagus because it is insensitive

Instruments suction and lighting apparatus are first carefully examined

The anesthetist usually takes his place to the left of the patient s head The operator sits or stands at the head of the table At his right hand is the assistant with the table of instruments The suction apparatus is directly behind the operator

The patient is placed on his back with his head well extended on the neck i e at the occipito atlantal joint This position must be maintained throughout the endoscopy

The raising or lowering of the head of the table provides the flexion or extension of the neck for the respective positions of the esophagoscope

The proximal end of the esophagoscope is held in the right hand pen fashion while the index finger and thumb of the left hand surround the tube The remaining fingers of the left hand are hooked over the upper teeth retracting the upper lip to prevent it from being pinched between tube and teeth

The handle of the instrument is directed upwards because in this position the esophagoscopist is aware that the bevelled end of the tube is pointing downwards

The tube proper is placed in the right angle of the mouth The point is guided over the side of the tongue until the epiglottis comes into view The bevelled end passing along the post pharyngeal wall and to the right enters the pyriform fossa Passing on another 2 to 3 cm the lumen disappears the upper sphincter of the esophagus (the crico pharyngeus) having been reached The end of the instrument is now directed towards the midline and concurrently is firmly elevated by pres sure of the left thumb With the next inspiration (or when the conscious patient is requested to swallow) the sphincter opens and the lumen of the cervical esophagus is observed dead ahead The tube slips through and passes easily onward

In this first introductory stage the head of the table must be raised so that the cervical esophagus is axially aligned with the upper half of the thoracic esophagus With the farther passage of the instrument the thoracic esophagus is reached Movements of expansion and contraction with respiration are seen The walls of

the closed esophagus are thrown into longitudinal folds leaving an irregular star shaped lumen *sometimes filled with esophageal contents*—e g mucus and food debris The aspiration tube may be passed down to remove these as it is of obvious importance at all times to maintain a *clear field of vision before passing the tube* farther down the esophagus

It is then seen that the lumen of the esophagus apparently *disappears anteriorly* To overcome this change in direction the head of the table is lowered simultaneously with the farther passage of the tube The aortic pulsations can be felt and seen when the left anterior wall is *examined*

The rest of the thoracic esophagus is readily traversed until the diaphragmatic level is reached By this time the head is lowered below the horizontal plane and the lumen of the esophagus again disappears but now to the left When the patient s head is moved laterally to the right and the anterior wall of the lumen is examined the lower sphincter appears This is seen as a vertical slit Slightly firm pressure is required to pass the instrument through it Progressing farther another 2 to 3 cm the cardia is reached It appears not as a constriction but reveals dark red folds *of gastric mucosa rolling into the tubal mouth and a gush of fluid from the stomach*

Endoscopic Appearances in Esophageal Cancer Time was when esophagoscopy was considered a difficult and dangerous diagnostic procedure, so much so that many years ago Bland Sutton remarked that it required the instinct of a sword swallower and the eye of a hawk

The normal esophageal mucosa is revealed as a smooth, even moist surface which is yellowish or bluish pink The folds are soft

The mucosa is variable to a slight degree In anemic persons it is apt to be whit ish pink

The gastric mucosa is of a darker pink hue than that of the esophagus

The chief conditions to note are the size and shape of the lumen the presence or absence of *normal movements the color and surface of the mucous membrane* (e pecially any tendency to bleeding) and lastly abnormal contents

The *endoscopic* picture as a rule is characteristic The important features of a malignant lesion are

(a) Presence of infiltration
(b) Rigidity of surrounding esophageal wall
(c) Loss of normal movements
(d) Friable nature of the tumor surface which *bleeds readily when lightly* touched with a cotton swab

If there has been a *long standing obstruction a fair degree of dilatation* of the lumen will be seen above the level of the growth especially if this is at the lower *end of the esophagus* As the stricture is approached the walls appear thickened by infiltration and do not show the normal respiratory movements Further careful cleaning by suction or mopping reveals the character of the surface of the growth

The picture varies according to the kind of growth Thus

(1) Polypoid
(2) Ulcerative
(3) Infiltrative beneath the mucosa (scirrhous kind)

(1) The lumen of *the esophagus* is obstructed by epitheliomatous exuberant

granulations (covered with purulent secretion) more or less pedunculated easily detached and bleeding at slight contact The projecting tumor may occupy more than half of the circumference of the lumen reducing the canal to a slit The attachment of the granulation is on a broad base which is elevated above the surrounding mucosa

(2) A more or less large ulcer is found on one aspect of the mucous membrane It is indurated and elevated The base of the ulcer is purulent The edges are projecting crateriform and bleed easily

(3) The wall in a certain area is raised and infiltrated beneath the surface It appears rigid contrasting with the mobility of the opposite side The surface of the area is smooth or granular and bleeds easily The infiltration may extend for some distance under the mucosa and reach the opposite wall so as to cause stenosis

Finally all varieties may be combined especially when the disease is advanced

The appearances common to all varieties then are *immobility and thickening of the wall upon which the tumor rests and abnormal tendency to bleeding*

Extrinsic cancer invading the esophageal wall may be present for a long time without involving the mucous membrane of the esophagus The significant signs at this early stage are

- (a) One or more of the normal creases between the folds are absent the lumen is asymmetric and large on inspiration
- (b) Palpation of the wall with the tube gives a sensation of rigidity
- (c) The involved wall is not readily made to wrinkle when pushed upon with the mouth of the instrument

Esophageal dilatation above a malignant lesion is rarely great because the stenosis is seldom severely obstructive until late in the course of the disease (Sometimes cancer is secondary to the dilatation)

When spasm or stricture has resulted in a dilatation of the proximal part of the esophagus care must be taken not to overlook a small growth which may have developed secondarily

Biopsy for Esophageal Cancer If deemed necessary a biopsy is carried out with circumspection because the procedure is not without risk and may cause infection hemorrhage or perforation

When symptoms are indicative of esophageal cancer and an inconclusive diagnosis is arrived at from roentgenograms tissue examination is of great importance Tissue can be obtained from the low or middle part of the growth with a retrograde bucket curette and accessories lately designed by Drs Armistead B Crump and George C Hennig

A hollow metal olive curette with four cutting edges atop is attached to a pliable metal staff A metal carrier and guide wires prevent injury The hollow flexible carrier is introduced into the esophagus up to the obstruction A blunt wire is then threaded through the lumen and beyond the end of the carrier until resistance is met The carrier is withdrawn a few centimeters the wire lightly rotated and slipped past the obstruction The carrier is again advanced and finally withdrawn and a perforated knob tipped flexible guide passed down over the first wire which is then removed (If it is found necessary the constriction can be dilated with graded metal bougies)

The curette is passed over the guide into the stomach and drawn back to obtain the desired tissue The curette is also manipulated under direct vision through the open end esophagoscope

Biopsy should be an essential preliminary to active treatment An early growth may be discovered when there is limitation or loss of normal enlargement of the lumen at each inspiratory act The growth itself may be visible and its site often indicated by the presence of blood stained mucus secretion

Differential Diagnosis in Esophageal Cancer It must be recalled that esophageal obstruction in a person over forty years of age, may be caused by

(1) Cicatricial stricture
(2) Tumors in the wall
(3) Cancer of the cardia involving the esophagus
(4) Extrinsic tumors
(5) Idiopathic dilatation of the esophagus
(6) Spasmodic stricture
(7) Diverticula
(8) Foreign bodies
(9) Plummer Vinson syndrome
(10) Diaphragmatic hernia

Normal esophagi as previously stated have an apparent constriction where the left bronchus or the arch of the aorta, presses against the esophagus on its left side A constriction at that place and nowhere else is likely owing to this cause

Narrowing of the esophagus by scars gummas and ulcers, is nearly always smooth and gradual in appearance cancer is characteristically abrupt and uneven showing either the everted edge of the growth or an undulating surface with nodular filling defect

Achalasia normally shows a rounded end to the esophagus terminating in a smooth straight short channel leading to a normal stomach however at times a somewhat circular rapidly constricting cancer may simulate the appearance of achalasia

In cardiospasm the symptoms of dysphagia are commonly of longer duration than in those examples in which obstruction is occasioned by cancer The patients are younger than those suffering from neoplasm *In cardiospasm difficulty in swallowing may vary in intensity whereas in cancer it is progressive* Complete esophageal *obstruction may be present in cardiospasm, however, relaxation usually occurs* within 36 to 48 hours Patients suffering from cardiospasm usually experience so much or more difficulty in swallowing liquid as solid foods whereas in patients *with cancer the reverse is true Epigastric pain is a common symptom in cardiospasm* and uncommon in cancer at the cardia

Auscultation is an additional way of discovering the presence and position of an esophageal stricture The thoracic end of the stethoscope is placed over the interval between the xiphoid cartilage and the left costal arch Two gurgling sounds are audible at this site if the patient takes one gulp of fluid the first is when it passes from the pharynx to the esophagus the second is when it passes from esophagus to stomach The normal interval between these two is six seconds but when there is an obstruction in the gullet this interval becomes increased If the first sound can not be distinctly heard the moment of its occurrence can be judged by looking at

the throat again and placing the stethoscope on the left side of the neck In a healthy person a gurgling sound will be detected during the act of swallowing This normal sound may be traced round and down the back on the left side of the vertebral spines so low as the tenth dorsal vertebra But if a stricture is present it will be delayed or absent below the stricture

Physical examination of patients with cardiospasm may reveal so much evidence of starvation as those suffering from cancer

The thorax should be examined fluoroscopically when it is often possible to detect extra-esophageal causes of dysphagia such as aneurysm mediastinal tumors and so on

Roentgenoscopic examination in cardiospasm usually reveals a smooth obstruction of the cardia although a small amount of food in the lower esophagus may produce an irregularity suggestive of neoplasm When extreme dilatation of the esophagus is present cardiospasm is always the underlying lesion

Moderate dilatation of the esophagus is observed both in benign and malignant obstructions Retention of secretions is more common in cardiospasm than in cancer of the esophagus and ulceration in the upper part of the tube is found more often in the former condition

Cancer of the esophagus is further differentiated from cardiospasm by the presence of filling-defects and the absence of notable dilatation from cancer of the cardiac end of the stomach by the absence of involvement of the stomach bubble as shown by roentgenograms from cicatricial stenosis of the esophagus by the age the history and roentgenograms

Cancer of the esophagus can usually be differentiated from benign pedunculated tumors by its shorter length greater diameter and rough surface

Extra-esophageal tumors tend to displace the esophagus

Pharyngo esophageal diverticulum sometimes requires differentiation from esophageal cancer If a duodenal tube or a large Ewald gastric tube is passed it may be caught in the diverticulum By backward pressure of the hand on both sides of the patient s trachea above the jugular notch a succussion sound is detected in the presence of a large diverticulum owing to the trapping of air and fluid in the diverticulum Roentgenographic examination is conclusive (The diverticulum is often found on the thoracic esophagus)

The differentiation of early lesions from tuberculosis and syphilis is not difficult so called peptic ulcers occur in the esophagus but lack the infiltration characteristic of cancer

A clear difference in the complaints of a patient with coronary artery sclerosis and one with a disorder of the esophagus is that the patient with the former condition does not have dysphagia and the patient with an esophageal lesion does It is also significant that retrosternal discomfort of cardiac origin is frequently brought on by exertion The distress of esophageal disease is not related to exercise but usually follows the eating of a meal however a characteristic of coronary artery disease is that it may develop postprandially

With coronary artery occlusion the anterior chest discomfort is often more pronounced in the precordial area than in the midline It is ordinarily described as a pressure or as an agonizing vise like or stabbing pain It is usually relieved

by sucking a nitroglycerine tablet Pain from esophageal disease does not have these characteristics and ordinarily is *described* as a soreness or ache

Dyspnea is rarely or never a symptom of esophageal disease unless respiratory tract complications develop, such as pneumonia atelectasis bronchial fistula and pleural effusion

Patients with a cardiac *neurosis* complain of precordial distress pain and dyspnea and may also complain of dysphagia on a functional basis

II Diagnosis and Differential Diagnosis of Gastric Cancer

The diagnosis is often not made early owing to the patient's unawareness of the gravity of or indifference to mild gastric symptoms and the careless or, regretfully enough incomplete clinical examinations and reliance upon a negative one despite continuance of symptoms It is for these reasons that more than one half of the patients with gastric cancer, when admitted to hospitals in the United States are considered inoperable

The causes of delay in diagnosis in summary may be listed as

(a) The character of the disease
(b) The patient and his prolonged persistence in personal medical care
(c) The medical attendant
(d) The radiologist

As in esophageal cancer the history alone is often suggestively diagnostic

This is equally true of the physical examination

The various procedures in arriving at a final diagnosis are

1 Physical examination
2 Roentgenographic examination (including fluoroscopy) of the stomach after administration of a barium meal
3 Gastroscopy
4 Laboratory examinations
   (a) Test meal
   (b) Occult blood test after meat free diet
   (c) Blood examination
   (d) Cytologic
   (e) Tissue examination after biopsy
   (f) Wasserman reaction
5 Exploratory laparotomy

Of these procedures one of great value is the examination of stomach contents for malignant cells

In some patients clinical evidence of gastric cancer and of inoperability is so definite that ancillary methods of investigation are unnecessary

The tragic aspect of the situation is that when a patient complains only of vague symptoms the lesion is far advanced

Highly suggestive are the following data

(a) Achlorhydria after successive injections of 0 5 mg of histamine phosphate at 20 minute intervals
(b) Concurrent pernicious anemia
(c) Family history of cancer

(d) Low hemoglobin values (11 0 or less)

(e) Occult blood in the stool

The early diagnosis of gastric cancer may be very difficult

In any person as previously stressed and restressed between the fourth and seventh decennia who has previously been in good health and then suddenly begins to complain of flatulence dull epigastric pain occasional regurgitation and vomiting associated with loss of weight and strength gastric cancer should be a valid assumption

Loss of weight is extremely significant especially if the patient has not changed his habits of life or has not been voluntarily dieting

The symptoms of gastric cancer have been described in a previous chapter but a few facts must be re emphasized

Absence of gastric symptoms all but excludes gastric cancer even when a tumor is present

Absence of free hydrochloric acid with duration of symptoms exceeding two years is in the main against the diagnosis of cancer Achlorhydria occurs in from 50 to 60 per cent of patients with gastric cancer and is a valuable although sometimes doubtful factor in establishing a diagnosis This is especially true of patients 55 years of age or older with achlorhydria because 15 to 25 per cent of normal persons in this category may be achlorhydric with or without histamine stimulus [94] Even high concentration of free HCl may occasionally be found in gastric cancer [95]

The first symptoms as previously stated may be trivial—slight epigastric distress after eating mild nausea anorexia eructations and so on

Of deep significance is the onset and rapid progress of dyspepsia and wasting *without previous gastric distress* especially in persons over forty years of age with absence of free HCl and the presence of a gastric tumor

Physical Examination

Inspection The presence or absence of extreme anemia should be noted as well as the presence or absence of an epigastric tumor

Palpation The patient should be carefully palpated while he is lying down and standing up The neck must be searched for hard enlarged glands especially in the supraclavicular area

By deep pressure and with forced inspiration on the part of the patient the examining fingers occasionally feel the cardia A mass may be felt Obviously the presence of a palpable mass varies with the site of the tumor in the stomach its size the habitus of the patient and the thickness of the abdominal wall

The cancer commonly taking origin at the pyloric end of the stomach when large enough to be felt as a firm and tender mass above and to the right of the umbilicus is frequently freely movable beneath the flat of the hand when the patient breathes deeply As the tumor grows it becomes irregular and by forming adhesions to surrounding viscera is less movable By direct spread it may seem united to the liver or the main mass may be felt composed of secondary glands along the greater or lesser curvature Anchorage at the umbilicus may be noted

(A swelling is most readily detected when the stomach is empty)

During the physical examination a surmise of metastasis from gastric cancer is suggested by the following disclosures

(1) Left supraclavicular area—a large, firm Virchow or Ewing node above the medial aspect of the clavicle A small flat, soft, non malignant gland can be felt normally Bilateral involvement is against malignancy

(2) Left axilla—a firm enlargement of nodes beneath the lateral edge of the pectoralis major muscle or deeper in the axilla in the absence of a similar node on the right side

(3) Umbilicus—the presence of a nodule fixation or undue induration

(4) Pre rectal cul de sac—a hard *shelf like projection or firm mass felt above the* prostate or in a similar position in women (rectal or Blumer s shelf)

(5) Vaginal examination—demonstration of malignant lesion in the ovary is suggestive of Krukenberg's tumor Primary gastric tumor is usually of the scir rhous variety

(6) Inguinal area—enlarged, firm nodes may be metastatic

(7) Skin nodules—rare

(8) Liver—irregular, firm enlargement is common in late conditions The as sociation of visible icterus ascites and a large irregular liver leaves little doubt of the presence of primary or metastatic hepatic malignant disease

(9) Ascites

If the growth is of the leather bottle variety it is usually readily palpable as a firm, shrunken tube like structure lying across the left upper abdomen

Rectal examination *should never be omitted in the investigation of any kind of* abdominal condition

Roentgenographic Examination *Expert roentgenography has superseded* all other methods and gives 95 per cent of accurate results

The opaque meal ordinarily consists of an *emulsion of barium carbonate—one* ounce to four ounces of the liquid This may be buttermilk water with gum traga canth and glycerine or any palatable liquid which keeps *well and which permits of* a good distribution of the barium salt by emulsion About 12 ounces are usually given The patient is ordinarily examined while standing and screened

The motor power and rate of stomach emptying are better studied with a more solid meal such as porridge or bread and milk containing barium sulphate

The examination should be made one quarter to one *half hour after the ingestion* of the barium meal where there is any difficulty in swallowing (or in patients who have had an abdominal operation which may have been a gastric anastomosis of some variety) screening should be accomplished at the time of swallowing the barium emulsion

The stomach should be empty of the liquid barium meal after three and one half hours Retention for five hours or more is almost always attributable to or ganic obstruction

Fluoroscopy There are features in the fluoroscopic part of the examination of the stomach which require special mention Before the opaque material is swal lowed careful attention is given to the gas bubble particularly as it is seen in the erect sagittal view

Valuable information can be obtained by a careful inspection of the gas bubble before the shadow meal is given The well-defined translucent shadow of the gas bubble may become small and irregular in outline or may even be absent owing

to the infiltrating growth which frequently takes root at the mesial border of the left dome and spreads over the surface of the fornix thus encroaching upon the translucent space of the gas bubble An additional reason why the gas bubble is small or absent altogether is that the cardiac sphincter is involved which because of its rigidity permits an easy escape of air

After a barium swallow a tumor mass stands out more clearly against the dark background magenblase The protruding tumor may obstruct the passage of the barium and divide it into two or more streams Kirklin pointed out that this examination is best carried out with the patient erect and a small amount of barium Complete filling of the stomach and examination of the supine and prone patient may obscure the tumor

Tumors of the cardiac area can often be seen as a mass of water density protruding into the air sac usually from the lesser curvature side

The first swallow of barium and water mixture is of the consistency of thick batter As this slides down the esophagus it leaves traces which demonstrate the mucosa Repeated deep inspiration is used to help the bolus along to demonstrate the diaphragmatic pinchcock action and to accentuate the normal undulating motion of the lower esophagus and the upper stomach Deep palpation with forced inspiration is carried out Both oblique and lateral positions as well as sagittal are used at this stage

The patient is then placed horizontally and the procedures described are repeated When the erect position is reassumed the barium should be found coating the mucosa giving a double relief pattern Either spot or conventional films can be used advantageously at this point

Finally the patient is given barium of cream consistency and told to swallow several mouthfuls rapidly In this way the lower esophagus is distended providing additional test of wall flexibility

Films should be taken with the patient supine prone and lateral prone

Negative roentgenographic data do not prove absence of malignant growth nor should a decision as to operability be based solely on this (fig 34)

In presumed malignancy anteroposterior roentgenograms are often all that is required and should be repeated in order to discover the size and contour of a filling defect If the first roentgenogram is suggestive of a growth projecting into the stomach it must be recalled the mucous membrane is very loose and thick (especially where the stomach is not distended) and is apt to be in folds Some of these may resemble the appearance of a malignant growth Eight ounces or more of barium emulsion should then be given in addition to the original barium meal and another film exposed Folded mucosa will then have taken up a new site but a malignant growth will still remain and if on taking another roentgenogram a few minutes later a part of the apparent filling-defect is still definitely of the same outline presumption of malignancy becomes almost a certainty The edge of the filling-defect caused by a cancer is usually definite and clear cut whereas that of folds of mucosa is usually hazy and less contourly definite

Cancers of the stomach are rarely multiple They tend to ulcerate and therefore at times simulate ulcers of a benign nature (fig 35)

In advanced stages the cells of the superficial spreading cancer infiltrate to the

serosa between muscle fibers *without* destroying them The penetrating cancer extends to the serosa by *destroying and replacing the muscle* The linitis plastica kind infiltrates the wall extensively, through the submucosa the subserosa and between the muscle cells *without* destroying the mucosa or obstructing the peristaltic movements of the stomach until late stages The linitis plastica variety of cancer is therefore not detectable either by roentgenograms (or by gastroscopy) until the growth is far advanced



Fig 34 — Annular carcinoma of pars media (Courtesy Maurice M Pomeranz M D New York City)

Diffuse Scirrhous Carcinoma The diffuse form of leather bottle stomach was first described by Brenton in 1854

The characteristic feature is the diminution in the size of the stomach which tapers from the fundus to the pylorus The organ is more or less horizontal mainly rigid and empties rapidly Its contours as a rule show slight irregularities Owing to diminished capacity esophageal dilatation commonly ensues a change which serves to differentiate the condition from total gastrospasm In the latter state the contour is more regular and gastric evacuation less rapid

Carcinomatous linitis plastica shows a lessened flexibility to radioscopic palpation and a tendency to fixation in its position in the manner of localized scirrhous lesions

The simple and syphilitic forms of generalized linitis plastica are similar in their radiographic appearances to those previously mentioned and cannot be differentiated radiographically from the malignant variety (fig 36)

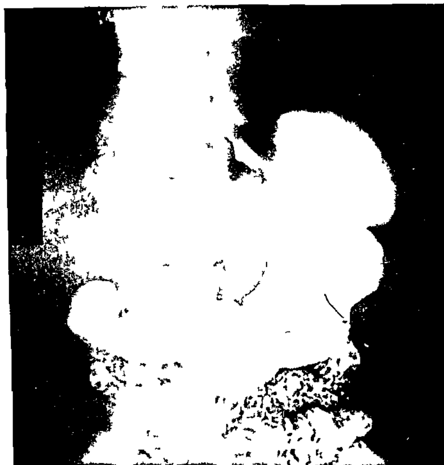


Fig 35—Carcinoma of cardia and lower part of esophagus (Courtesy Maurice M Pomeranz M D New York City)

Scirrhous Cancer of the Pyloric Area In this area the growth is ordinarily annular and consequently causes early obstruction The differentiation from simple cicatricial stenosis or the hypertrophic pyloric stenosis of adults is not readily made In cancer the stenosed passage as a rule is longer and more irregular than in simple stenosis

Medullary Encephaloid or Fungous Cancer The local form of leather bottle stomach starts at the pylorus spreads slowly in the direction of the cardia and is associated with a great deal of fibrosis

Advanced scirrhous cancer also presents a characteristic picture The viscus

often becomes funnel like The final contour depends on the extent of involvement If limited to the pylorus there may be a localization area of narrowing with irregularity of contour and destruction of the *normal mucosal* markings



Fig 36 — Infiltrating carcinoma cardiac end of stomach (Courtesy Maurice M Pomeranz M D New York City)

On examination the pyloric part of the stomach is found to be pearly white thickened and rigid and densely hard

The following conditions may be mistaken for, and may in fact be indistinguishable from the localized form of leather bottle stomach

(1) Hypertrophic tuberculous pyloric disease

(2) Syphilitic gummatous pyloric infiltration
(3) Localized form of fibromatosis
(4) Scirrhous pyloric cancer
(5) Chronic pyloric cancer associated with extensive scarring of the submucous coat

If the sclerosing process is extensive the pylorus may become almost completely obstructed and the uninvolved stomach proximal to it may then be greatly enlarged and show retention of contents for a few days The entire stomach is not infrequently involved

The defect is jagged and permanent During fluoroscopy the opaque meal can be seen by passing the defects Occasionally the filling defect is interpreted as a spasm but after thorough atropinization the defect still persists Shifting the patient in various directions does not alter the position of the growth It will be noted also that the peristaltic waves fail to pass over the involved area The peristaltic wave may end at the lesion or seem to miss the defect and then begin again

According to Sommervell[96] a filling defect of the stomach after the taking of a barium meal may be caused by

1 Food in which case it will be near the pylorus or in the lowest part of the stomach and will have a gently shaded edge

2 Pressure from without as of vertebrae or of a full or firm transverse colon (which often simulates a greater curvature cancer) or of a rounded pancreatic cyst

(If a pancreatic tumor for example has already invaded the stomach the differentiation by roentgenograms alone may be impossible)

3 Hypertrophy of the mucosa the folds of which may simulate cancer especially in the upper part of the greater curvature

4 Benign tumors which are usually rounded and seldom have the definite clear-cut edge of a cancer

5 Foreign bodies such as hair ball (not likely in middle aged man)

6 Contracture of the stomach wall such as occurs opposite an ulcer

7 The lines of the rugae between the folds of the mucosa are absent in all those parts that are occupied by the growth

8 If the cancer simulates an ulcer there will be less regularity and symmetry than in the average benign ulcer

9 No peristaltic waves are seen in those parts of the stomach wall which are involved in the growth

10 The apparent size of the stomach is smaller in cancer that involves the organ except in those examples of pyloric cancer in which there is obstruction in these the stomach is enlarged

Fungating and Polypoid Tumors Fungating and polypoid tumors are bulky cauliflower like masses which project into the lumen of the stomach As a rule they take root in the body of the stomach in the area of the greater curvature posterior wall or fundus and reveal a relatively narrow base infiltrating only a small area of the gastric wall Owing to their bulk they plug the outlet of the stomach thus causing pyloric obstruction

In the medullary encephaloid or fungous cancer the filling-defect the main roentgenographic feature is different from that of the scirrhous variety In addition to the irregularity occasioned by intramural infiltration similar to but more irregular than that of a scirrhous infiltration gaps are observed in the barium shadow

caused by the projection of the tumor mass into the gastric lumen These additional defects ("fingerprint"), not invariably present are rounded or oval and discrete (fig 37)

In many examples there is a large irregular gap in the barium shadow frequently with jagged edges These fungous filling-defects for diagnostic purposes should be fairly constant in a series of roentgenograms allowing for variation in the amount of opaque cream in the stomach The filling defects on the periphery of the gastric shadow show least change those within the gastric contour (because of tumor



Fig 3[illegible] —Large malignant ulcerating lesion involving almost entire lesser curvature of stomach (Courtesy Maurice M Pomeranz M D New York City)

masses on the anterior or posterior wall) may vary greatly depending on the amount of opaque cream which distends the stomach The other roentgenographic signs namely focal peristalsis rapid emptying gaping pylorus lessened flexibility and mobility of the gastric wall are all obvious in this kind as in the scirrhous

The presence of a palpable epigastric mass is more common in this variety than in the scirrhous but it is a late feature in both The esophageal dilatation and X hour glass pattern do not characteristically occur

The mucosal relief pattern in fungous cancer shows a striking and abrupt altera

tion of the regular pattern into a completely irregular one in the zone involved by the tumor This destruction of the normal configuration is more noticeable than in the scirrhous kind

Sites An early fungous growth on the anterior or posterior wall may not be seen because of over filling of the stomach with barium cream It is best therefore to examine the stomach when it is filled only with a small amount of barium

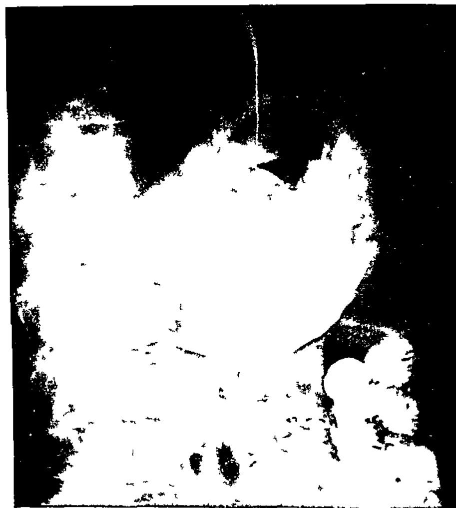


Fig 38 —Infiltrating tumor greater curvature (Courtesy Maurice M Pomeranz M D New York City)

Carcinoma of the fundus is usually of the encephaloid variety It produces a filling-defect best observed with the patient supine (fig 38)

Growths which involve the cardia as a rule are primarily esophageal spreading to the stomach around the cardia A narrowed tortuous tract is observable owing to obstruction (figs 39 40)

At the fundus the gas bubble may disclose a tumor in relief

The filling of the fundus by barium cream may appear abnormal because as the cream pours from the cardia it may pass irregularly over the tumor mass

The mucosal pattern is cut short by the tumor mass and the filled fundus shows a filling defect



Fig 39 —Carcinoma lower esophagus Woman age 60 (Courtesy Maurice M Pomeranz M D New York City)

Cancer of the pylorus or near it which is obstructing the outlet of the stomach shows a filling-defect combined with some degree of dilatation or hypertrophy of the stomach (fig 41–43)

Differentiation Between Benign and Cancerous Ulcer Cancer developing in the edge of a simple peptic ulcer cannot be detected in the early stages

At a first examination the ulcer which has undergone malignant degeneration reveals a large crater which if of a diameter of one inch or more should raise the

presumption of malignancy The presence of a filling defect contiguous to the crater is also suggestive (A gap caused by mucosal edema may be mistaken for a carcinomatous filling defect)

The meniscus is a pattern seen in many malignant ulcers of and near the lesser curvature It consists of a translucent zone 1 or 2 mm in width separating the barium filled crater from the main barium mass filling the gastric lumen Kirklin



Fig 40 —Carcinoma of lower end of esophagus Male, age 49 (Courtesy Maurice M Pomeranz M D New York City)

stated that it is caused by the growing malignant edge of the ulcer and should be remindful of malignancy (Sometimes a marginal edema is the cause of the meniscus)

(Many of the malignant ulcers are slow growing and gastric acidity may be normal)

In a characteristic peptic ulcer the niche protrudes usually from a broader smooth

base outwardly, commonly at the lesser curvature, has smooth margins and is sharply defined from adjacent parts There may, however, be inflammatory thickening of the margins with resultant scarry contraction This may result not only in hour glass deformity but in a straightening and shortening of the lesser curvature



Fig 41 —Infiltrating mass extending from lesser to greater curvature (Courtesy Maurice M Pomeranz M D New York City)

with a consequent snail stomach ' eccentrically placed pyloric canal Characteristic also is the radial arrangement of the gastric rugae around the ulcer or its scar

The feature of a characteristic cancer crater is different in that it protrudes inwardly as a filling defect its base remains within the projected outline of the stomach and is not sharply demarcated from the circumjacent rigid and rigged mucosa The contour of the filling defect is irregular Almost pathognomonic is Carman s

meniscus sign previously referred to Because the crater is surrounded by new growth tumefaction it appears as a 'halo when seen *en face* and as a negative shadow meniscus when seen tangentially Peristaltic waves and mucosal rugae are obliterated in the surrounding area



Fig 42 —Infiltrating neoplasm involving lesser curvature about 3 cm above pylorus (Courtesy Maurice M Pomeranz M D New York City)

Diverticula of the stomach or duodenum sometimes may resemble an ulcer niche or cancer crater Gastric diverticula are usually found near the cardia at the posterior wall duodenal diverticula in the second and third part of the duodenum and not in the bulb as contrasted with duodenal ulcer The junction of the pouch with its base is narrower than the pouch giving the appearance of a neck

Radiographic Appearance of Benign Tumors In a roentgenographic examination

it is extremely difficult and often impossible, to demonstrate a subserous pedunculated tumor The intragastric polypoid tumors, however, are readily demonstrable with circumspect technic



Fig 43—Large infiltrating mass involving upper part of body and gastric fornix (Courtesy Maurice M Pomeranz M D New York City)

When the tumor is small or single it is completely obliterated by filling the stomach with an opaque cream The mucosal pattern technic is required to demonstrate the growth

If the tumor is single and large it shows in a mucosal relief picture and usually produces a round and movable filling defect in the filled stomach (figs 44 and 45)

Multiple polypi produce characteristic filling defects—many small rounded gaps in the barium shadow scattered throughout the stomach

Intragastric benign tumors can be readily revealed by air insufflation of the

stomach especially if it is used with the previous administration of colloidal barium The rounded marble shadows of the polypi in gastric polyposis show clear contours in obvious contrast to the disrupted contoural irregularity of an intragastric encephaloid carcinoma (figs 46–48)



Fig 44—Entirety of stomach involved in linitis plastica (Courtesy Maurice M Pomeranz M D New York City)

Diagnosis by Geiger Counter A Geiger counter small enough to be swallowed by a patient is being used to locate cancer of the stomach

According to a report from Harvard University cancer tissue in the stomach absorbs two or three times so much radioactive phosphorus as surrounding normal tissue It is maintained that if a tumor is present in the stomach the radioactive phosphorus tends to concentrate within the cancerous mass The radioactive phosphorus is injected into the patient s body

Radioactive phosphorus is a "hot" element, made in atomic piles or furnaces by the Atomic Energy Commission It gives off rays as it disintegrates The rays can be detected as a "click" on a conventional radiation detector The 'hot' phosphorus is considered to be where the "clicks" are more numerous



Fig 45 —Large infiltrating mass lesser curvature contiguous to fundus (Courtesy Maurice M Pomeranz M D New York City)

When the radioactive phosphorus is administered according to the Harvard report the concentration within the tumor mass is revealed by the frequency of the clicks in comparison with the frequency of surrounding normal tissues These unaffected tissues absorb the hot phosphorus but to a less degree

The concentration of radioactive phosphorus in a tumor and the tumor site within the stomach may be signaled by the tiny recording head of the Geiger counter

according to the report The counter head is swallowed by the patient with electrical leads' extending through the throat and mouth to a conventional radiation re corder The Geiger counter head can be manipulated within the stomach until it rests adjacent to the tumor



Fig 46—Malignant ulcer size of hen s egg at cardiac end of stomach (Courtesy Maurice M Pomeranz M D New York City)

Resumé To be kept in mind are the following classical signs in diagnosis

(1) Deformity produced by a cancer remains unchanged It is persistent as to site and configuration It withstands manipulation Subsequent examination re veals no change in the original observation

(2) Permanent changes in the gastric outline especially the filling-defect

(3) The edge of some part of the filling-defect and in greater curvature growths almost the whole border of the defect is hard and definite unlike the soft edge of

mucosal folds of rounded innocent tumors (Filling-defects are usually understood to mean defects either of addition or of subtraction to the outline or contour of the stomach The filling defects of subtraction are usually associated with a new growth)

(4) Rigidity of an area of the gastric wall, which is aperistaltic It is only in the later stages of the lesion that peristalsis stops at the site of the lesion It is then



Fig 47 – Carcinoma of stomach with secondary carcinoma of lymph nodes (Courtesy Maurice M Pomeranz M D New York City)

definitely significant but when the waves pass without interruption it does not necessarily indicate that no new growth is present

(5) Changes in the mucosal pattern

(6) A palpable mass with other signs

(7) The edge of the growth has a cubist appearance

(8) Palpation of the stomach during screening does not change these filling defects as it so easily deforms the shape of the stomach

Filling defects caused by pressure from an external lesion differ from those of an intra gastric lesion

It is to be recalled the greater curvature of the *normal* stomach is not always smooth in outline but is often serrated so much so that the appearances may be mistaken for cancer and conversely



Fig 48 —Neoplastic infiltration involving pars prepylorica (Courtesy Maurice M Pomeranz M D New York City)

Electrogastrograms A tracing of electric changes caused by gastric muscular contractions sometimes furnish a specific curve for early establishment of a diagnosis of cancer

Gastroscopy

Historical Notes It appears that Kussmaul (1868) made the first direct examination of the esophagus He used an urethroscope of 43 cm in length and was able

to see a cancer of the thoracic esophagus by the rays of light from a naked flame reflected down a long straight wide tube (The incandescent electric bulb was still to be invented)

In 1871 Desormeaux suggested the general principles of endoscopy and five years later the first indirect vision gastroscope was made by Nitze of Vienna This instrument had an optical system resembling that of the cystoscope of our day, with an electrically heated incandescent platinum wire as the source of illumination

Einhorn in 1902 added an ancillary tube in the wall of the basic one and therein placed a light carrier to serve as a conducting wire to a small electric lamp which it carried at the distal end of the tube

In 1932 George Wolf, an optical technician in collaboration with Rudolf Schindler, perfected the present day half flexible, half rigid, gastroscope

Wolf Schindler Gastroscope This gastroscope resembles a large cystoscope with an eye piece It has a flexible shaft, a strong terminal light and a Wolf lens placed proximal to the illumination

The instrument can only be rotated or moved in or out of the stomach It cannot be moved sideways To obviate this the patient is moved in different directions

There are 52 lenses in the flexible gastroscope Each lens is of short focal length carrying the image to the next lens The lower half of the instrument is flexible making it safe and easily passed by the trained person

Various parts of the stomach can be studied by rotating the instrument When introduced to its maximum depth and directed to the pylorus it is possible to see that part of the stomach in about 50 per cent of patients depending on the contour of the viscus It is difficult and sometimes impossible to see the pylorus in a J shaped stomach

A number of gastroscopes are now procurable One is equipped with an electro magnetic switch for mirror control at the distant end thus changing the viewing angle Another has a ratchet on the handle which permits proximal control of the distal flexible part of the gastroscope Still another gastroscope contains a channel for aspirating secretions and for passing a biopsy forceps

Mr Ludwig Streifender (Eder Instrument Company) developed a new gastro scope which has a longer rigid part, thereby giving greater illumination and better views

The flexibility of the tip is obtained by means of a small wheel near the eye piece which raises or lowers the tip of the instrument when in place

The Korbasch gastroscope is a modified rigid one

Indications for Gastroscopy Gastroscopy should be complementary to roentgeno graphic examination

In general if the roentgenographic diagnosis is positive gastroscopy, as a rule is unnecessary However additional information thus obtained concerning the extent and degree of invasion of the lesion may be of great value to the surgeon in planning

To begin with a negative gastroscopic examination does not exclude the diag nosis of cancer Many growths at the pylorus and so called blind areas cannot be seen through the instrument If cancer is of the invasive intramural variety which

does not involve the mucosa until late gastroscopic data obtained may be negative or inconclusive

If in the examination of a patient, after consideration of the clinical facts the radiographic report the result of test meal examinations and tests for occult blood a conclusive diagnosis is arrived at upon which surgery is indicated then gastroscopy is not required Even with the most thorough clinical tests a final diagnosis may remain inconclusive

If a roentgenographic examination has already demonstrated the presence of an advanced cancer gastroscopy will be a work of supererogation not without risk

Schindler[97] wrote

> Gastroscopy should lead to frequent discovery of the precancerous conditions of polyps and of atrophic gastritis and their careful observation should permit early discovery of very small symptomless cancers and thereby a substantial improvement in the prognosis of this disease

Gastroscopy rarely provides decisive indications for either a surgical procedure or the planning of a medical regime (Tissue biopsy is not possible with the widely used flexible gastroscope and the rigid gastroscope through which biopsy specimens can be obtained is only suitable for the diagnosis of lesions at the gastric cardia)

Gastroscopy is invaluable in the diagnosis of gastritis It should be carried out with positive and negative observations only when the following indications are present

(1) When there is a long history of indeterminate abdominal symptoms with negative physical laboratory and roentgenographic observations Small shallow gastric lesions not detectable by roentgenograms are often found

(2) Neurotic patients with dyspeptic symptoms but without positive indications on repeated examinations

(3) Undetermined loss of weight anorexia or persisting nausea may be caused by an early gastric cancer unrevealed in roentgenograms

(4) Occult hematemesis or melena when gross hemorrhage has subsided for a safe period of time

(5) Positive roentgenographic observations or definite gastric pathology

(6) Persistent symptoms after gastric resection or anastomosis

(7) When a diagnosis of gastric malignancy has been made clinically and roentgenographically gastroscopy may be assistive in determining the possibility or extent of resection (Excessive inflammation of the gastric mucosa surrounding a malignant lesion may simulate extensive invasion of the gastric wall on the roentgenogram while gastroscopy may help to reveal that the malignancy is more limited and resection is still possible)

(8) Healed gastric ulcer in which the niche has disappeared at the final roentgenographic examination and when the lesion is in an area accessible to examination Ulcers believed to be healed by clinical and roentgen ray evidence may still show activity under gastroscopic investigation There are examples which in time are considered to be a recurrence of an old ulcer or a new malignancy but which are only a continuation of the primary process

(9) When the diagnosis of a duodenal ulcer is conclusive and if a resection is contemplated a preliminary gastroscopic examination is exigent

(10) Pyloric obstruction where a definite roentgenographic diagnosis of the basic pathologic process is often difficult, gastroscopy may be of value

There are actually only four important indications for gastroscopy, namely

(a) Gastric ulcer, benign or malignant
(b) Symptomatic gastritis
(c) Hematemesis
(d) Unclassified gastric tumor

Contraindications to Gastroscopy

(1) Seriously ill febrile patients
(2) Trismus
(3) Bronchitis or other pulmonary conditions associated with cough and dyspnea
(4) Aortic aneurysm
(5) Esophageal stenosis
(6) Esophageal web
(7) Esophageal varices
(8) Esophageal diverticula
(9) Enlarged mediastinal glands
(10) Cardiospasm
(11) Angina pectoris
(12) Spinal arthritis
(13) Mediastinal lesions
(14) Severe cervical or dorsal spinal curvature
(15) Advanced cardiovascular disease—cardiac decompensation coronary disease extreme hypertension
(16) Extreme debilitating conditions such as advanced pulmonary disease fever, peritonitis kypho coliosis epilepsy
(17) Jaundice without proper vitamin K preparation
(18) Psychosis
(19) A large cancer near the cardiac orifice may render the examination impossible and it should not be attempted within a few days of a severe hemorrhage
(20) Corrosive gastritis
(21) Phlegmonous gastritis
(22) Peritonitis
(23) Fever particularly if considered to be of abdominal origin

The principal contraindication it will be seen, is *disease in the esophagus* It is unwise to pass the gastroscope on any patient who complains of dysphagia until an open tube esophagoscopic examination has been performed Roentgenographic examination of the esophagus and stomach as previously stated should *precede* gastroscopy

The examination is not undertaken during an exacerbation of ulcer pain because distension of the stomach may possibly cause a perforation of the softened base of an active ulcer

Circumspect scrutiny is often extremely difficult owing to the motility of the stomach the transmission of diaphragmatic respiratory movements and the movements of the mucosa proper Localized lesions may consequently be observable at one time and not at another Then again the degree of air inflation influences the mucosal pattern

The gastroscope permits only the visualization of the gastric mucosa The sub mucosal layers cannot be seen nor the anatomy of the duodenum or esophagus

The illumination obtained through the semi flexible gastroscope is adequate to a degree however obfuscation frequently interferes with careful study of mucosal changes As a matter of fact the lesions scanned through the semi flexible gastro scope appear smaller than in reality

The Blind Spots These are situated in the following areas

1 Greater part of the lesser curvature in the pre pyloric area
2 Small part of the greater curvature where the tip of the instrument rests
3 Area covered by the mucous lake
4 Part of the cardia
5 Various parts of the posterior wall (at times)

The most important of these blind areas is the pre pyloric one because it is a frequent site of lesions

There are four methods of overcoming to a large extent the inadequacies of the instrument namely (a) use of the omniangle gastroscope (b) shifting of the patient to his right side (c) abdominal palpation and (d) upright gastroscopy

When the patient is upright the inflated stomach assumes a rather globular form determined mainly by the left lobe of the liver diaphragm spine spleen left kidney and anterior abdominal wall

The omniangle gastroscope increases the range of vision from the usual 45 degree angle to a 70 degree angle The instrument has a new optical system with a tilting mirror instead of a prism at the distal end The mirror is operated by a small mag netic solenoid control by a switch in the handle By tilting the mirror the field of vision is increased

(The gastric mucosa can now be studied by means of simultaneous radiographic and gastroscopic examination A contrast medium composed of equal parts of dio drast and a saturated aqueous solution of methyl cellulose is found to be satis factory for mucosal relief studies)

Pneumogastroscopy is a valuable means of producing controlled intragastric pressure to determine the mobility elasticity and motility of the gastric wall and mucosal pattern

Disadvantages of Gastroscopy Some of the disadvantages of gastroscopy are as follows

(a) The transient pressure of the hot lamp on the mucosa causes localized con gestion and outpouring of mucus in the area affected

(b) Instrument friction on the mucosa produces superficial ecchymosis and may induce bleeding

(c) The gastric suction used to empty the stomach prior to endoscopy may cause a superficial erosion or bruise colored with altered blood The so-called pig ment spot may result from prior suction in fractional test meal examinations

(d) It is not known to what extent certain changes, e g increased motility, congestion spasm or increased secretion, may occur as a consequence of the presence of the foreign body—the gastroscope

Technic of Gastroscopy It is best to wash the stomach thoroughly with a weak solution of bicarbonate of soda and to aspirate the content completely about one half hour before the endoscopy is begun

The intramuscular injection of atropine sulphate 1/100 grain, one half hour beforehand facilitates the esophagoscopy by diminishing gastric secretion

The investigation can be accomplished with or without anesthesia

After induction of narcosis intravenously (or the cocainization of throat and pharynx) the instrument is passed into the stomach Air is pumped into the viscus to produce a moderate dilatation (The shape of the stomach is altered during gastroscopy when air is introduced therein So much as 1500 to 2000 cc can be introduced during the course of a gastroscopy)

Because of its flexibility the gastroscope can be maneuvered into the various parts of the cavity of the organ and a good view obtained of the greatest part of its lining Gastric juice mucus etc, which may obscure the field of vision can be wiped away by rubbing the lens meticulously against the gastric mucosa

There are three technics in gastroscopy—open tube, the lens system and a combination of the two The open tube instrument is required for removal of foreign bodies or of a tissue specimen for histologic examination

The lens system has the advantage of a larger field of vision with a magnifying image

The Wolf Schindler distal half flexible lens gastroscope greatly facilitated gastroscopy and consequently reduced its attendant risks The danger in gastroscopy lies in trauma during the act of insertion The first and greatest danger area at this time is where the esophagus is closed by the cricopharyngeus muscle The second danger area is where the esophagus is closed at the hiatus esophageus by the diaphragmatic musculature drawing on the crura

The mediastinum or pleural cavity may be inadvertently entered with many resultant complications

In the left lateral position of the body (as in preparation for gastroscopy) the inflated stomach which is free of the influence of the instrument elongates straightens and rises obliquely to the right along the nether aspect of the right lobe of the liver A roughly tubular organ is thus formed with about 75 per cent of it lying to the right of the esophageal axis

The distal centimeter or two of the esophagus may often be visualized with the flexible gastroscope of the ordinary lateral objective kind The adjacency of the esophageal mucosa appears a brilliantly white orange

The esophageal gastric union is revealed by a projecting crescentic mucosal shelf the cardia crescent which projects caudadly into the field of vision from the anatomic left anterior quadrant of the cardia

The fundus has the least distinctive appearance of any area in the viscus

The pars media is somewhat flattened antero posteriorly During the investigation different aspects of the pars media can be brought into unclouded view by external manipulative pressure on the abdominal wall

The patient s vertex must rest about 15 cm above the table level for the instrument to pass through the cervical esophagus and 2 cm or more *below* the level of the table in order to pass through the abdominal esophagus Owing to different planes of the axis at the respective locations the patient s head must be kept high and then low This sequence consists in keeping the patient s head and neck supported away from the table An assistant holds the bite bloc while a second one controls the patient s shoulders down on the table

The gastroscope is lubricated and held in the right hand The guiding left fore finger is introduced over the base of the tongue into the right pyriform fossa The instrument is then passed posteriorly and downward into the esophageal opening

The patient s head is now raised slightly The obturator of the gastroscope is withdrawn the light turned on and the introduction completed by direct vision Pressure is never of course exerted on the gastroscope

The esophagus is scrutinized ahead of the gastroscope and while passing it into the stomach

Particular care is exercised in passing the gastroscope at the diaphragmatic hiatus

When the instrument is in the stomach a regular plan of examination is followed The walls are searched in transverse and vertical strips In the latter technic the esophagoscopist begins at the left fundal extremity and passes his instrument from the lesser to the greater curvature It is then shifted slightly to the right and another strip examined in turn This procedure is repeated advancingly until the pylorus is reached

In making an examination by the horizontal strip the instrument is lowered to the greater curvature and passed from the cardia to the pylorus It is then withdrawn somewhat and passed in the opposite direction This procedure is continued until the lesser curvature is reached

At the completion of the examination the instrument is carefully withdrawn

According to Jackson[93]

The interior of the stomach is examined at three depths The first level at which the stomach is studied is the deepest part that the instrument can be introduced When the gastroscope is passed to its greatest depth the rubber finger rests on the greater curvature This is termed depth I If the instrument is pushed farther in the rubber finger bends and the greater curvature is pushed downward

At depth I the angulus antrum and pylorus are observed It is best to start with the ocular so adjusted that the objective will face the anterior wall This is accomplished by placing the handle or button of the gastroscope at nine o clock The ocular is then slowly rotated clock wise so as to make a complete revolution As this is done observations are made of the anterior wall lesser curvature posterior wall and greater curvature The ocular is then rotated counterclockwise returning to the original position

The stomach is then examined at depth II This is the middle part of the stomach This is accomplished by withdrawing the instrument to a point where the angulus disappears from view Here the same procedure is followed as in depth I Observations are made as the instrument is rotated clock wise and counterclockwise

The next level at which the interior of the stomach is observed is just below the cardia depth III This is the upper part of the stomach This level is reached by withdrawing the gastroscope to a point where a clear view is beginning to be lost At this point the scope is gently pushed forward until a clear view is again obtained Now the rotation of the instrument is repeated as in the previous examinations When this is finished the gastroscope is withdrawn from the patient

Gastroscopic Appearances

The Normal Gastric Mucosa This is of uniform color and consistency except along the greater curvature of the antrum Over the fundus pars media and walls of the antrum it is orange red There is a minimal but clearly seen translucency of the smooth mucosal surface

In the normal stomach peristaltic waves are observed passing regularly from the angulus to the pylorus The size of the rugae depends upon the amount of air introduced into the stomach (The objective of insufflation of air is to cause sufficient separation of the folds so that the observer can be certain no small localized lesions remain hidden)

The constant gastric movements cause multifarious prominences, recessions, contoural and dimensional changes

The color varies greatly even in the normal The degree of illumination and presence of food also deepen the color Under the open tube gastroscope the gastric *mucosa appears deep pink, while the esophageal mucosa is pale, rather bluish pink* it is deeper yellowish pink while passing through the hiatal pinchcock into the stomach The lens system rigid instrument shows the esophageal mucosa pale pink the gastric mucosa pale orange red—a deeper red with the flexible gastroscope

Along the greater curvature of the antrum the mucosa has a gray tint, superimposed on the orange red

In the normal stomach blood vessels are rarely seen gastroscopically

In many gastric ulcers for example there are, at first but slight visible changes The main facts to keep in mind are that any secondary malignant change has usually an entirely local origin somewhere at the mucosal edge of the ulcer and that as it progresses the mucosa becomes thicker and more firm and nodular than that bordering the rest of the ulcer In time the thickening tends to extend, still in the mucosa, outwards from the ulcer and around the margin of the crater At the onset there is little tendency to invasion of the ulcer floor and not until the mucosal thickening has progressed completely around the ulcer does general deep invasion of the stomach wall occur

According to Schindler[99] the nodules on the surface of a benign tumor are regular granular and rather uniform in size whereas in malignancy they are irregular and variable some very large and some small In hypertrophic gastritis the nodes are not so stiff and no solid tumor like protrusion is observed

Microscopic Appearances of Ulcer-Cancer The theory that cancer of the stomach frequently develops on chronic benign ulcer is often difficult if not impossible to prove Not uncommonly ulcers of the stomach are observed in which one part is benign and another malignant This does not imply cancer is developing in a previously benign lesion

It is widely known that certain malignant ulcerations resemble benign *ulcers* in regard to symptoms, gastric analysis, roentgenographically and gastroscopically and as to their response to conservative therapy for a period of time only *to manifest themselves* as obvious cancer at a later date Fourteen per cent of the patients treated at the Massachusetts General Hospital over a ten year *period for benign* gastric ulcer were proved to have cancer[100]

There are four criteria in which a simple ulcer usually *differs from cancer* of the

stomach (a) complete destruction of an area of muscle corresponding in size roughly to the floor of the ulcer (b) presence of a large area of dense fibrous and granulation tissue in the floor of the lesion (c) presence of endarteritis obliterans or thrombo phlebitis in the surrounding vessels (d) fusion or closer approximation of the muscu laris mucosae and muscularis at the margin of the ulcer

A simple gastric ulcer is seen to have a crater the floor of which is whitish and the depth variable being shallower in slighter or healing examples while the more chronic ones show a deep crater The edge of the ulcer is usually clear cut or over hanging except in healing ulcers in which it is shelving The mucosa just outside the edge is thickened and shows a heaped up appearance most noticeable in the recurrent examples and in those which are undergoing malignant change From this thickened edge folds of mucosa run radially owing to the tendency of cancer scar tissue to adopt a radial formation

The Active Acute Ulcer Here there is peripheral reaction with edema elevation and a band of hyperemia The ulcer edges themselves however remain sharp and clear The base often oozes blood The crater seldom measures more than a centi meter There is rarely more than one lesion present and then they tend to be grouped So distinctive as its gross appearance is its quick development and quick healing

Active Chronic Ulcer The crater is a prominent discrete lesion Its outline is usually circular without irregularity

Moutier[101] wrote that most ulcers are oval their long axis being either parallel or perpendicular to the axis of the lesser curvature the elongation being caused by contraction of adjacent vessels in addition the ulcer is usually visualized obliquely by the gastroscopist

The smooth gray yellow base is often clean and covered by a thin fibrin layer but it may be obscured by mucus exudate debris or dark-oozing blood The edges show a rather abrupt roll The entire circumference is sharp and discrete indicative of its benign nature Rarely is there elevation of the edges There is no hyperemia of surrounding mucosa but rather the mucosal color is homogeneous to the edge of the crater

(Schindler[107] emphasized the fact that benign ulcers bleed from the crater s center while malignant ones bleed from the edge)

Carcinoid (Argentaffinoma) of the Stomach The carcinoid is a tumor resembling cancer histologically but not in behavior Gossett and Masson[103] showed that char acteristically the cells of such tumors contain cytoplasmic granules which reduce silver ammonium oxide and suggested that the tumors arise from the Kultschitzky cells on the base of the glands of Lieberkuhn Because of the presence of the specific silver granules the carcinoid tumors have also been called argentaffinoma

Gastric Mucosa Biopsy The gastric mucosa biopsy tube based on the principle of suction and introduced by Wood[104] *et al* has made it possible to obtain excellent full thickness mucosal specimens with certainty safety and ease and with the aid of a gastroscope

It is contended that biopsies are possible only from limited areas close to the objective that is from the posterior wall which may not be representative of pa thology in other parts of the stomach

Technic Following throat anesthetization the biopsy tube is passed in the seated

patient and the stomach is drained through it as is usually done prior to gastroscopy By gauging the depth of introduction and governing direction of the tube s cutting hole it has been found possible to select within a few centimeters (as checked later with the gastroscope) the biopsy area An assistant makes sudden suction with the syringe and immediately indicates whether resistance is felt If it is, the wire controlling the cutting cylinder is quickly pulled up a centimeter cutting off the piece of mucosa which has been drawn through the hole on the side of the metal tube The instrument is withdrawn and the specimen quickly placed in a fixative After the biopsy is taken the patient is placed in the left lateral position and gastroscopy is carried out

Sponge Technic Two methods are utilized to place sponges in a fasting stomach The test is begun a little after 9 a m the patient having abstained from food and drink for the previous 15 hours

Method I Nine to 12 small pieces of fine pore specially prepared synthetic cellulose sponges (Gelfoam No 12) each 1 0 x 0 5 x 0 5 cm , are tied to the nether end of a piece of No 3 white braided silk at intervals of 2 5 centimeters The lower end is weighted with a small metal bulb such as the Rehfuss duodenal bulb

Method II Twelve to 15 small pieces of sponge are tied at similar intervals along the braided silk and then securely wound in spirals along the lower part of a Levin stomach tube for a distance of 30 centimeters A small hole in the tube, 30 cm above the lower end permits passage of the silk through the lumen and firm ligature of the two free ends prevents slipping The sponges string and tube are placed momentarily in cold water before they are swallowed A marker 75 cm above the lower end indicates the approximate distance from the incisor teeth to the pylorus After the sponges have reached the stomach the patient is requested to lie on the right side and the upper part of the abdomen is massaged by moderately firm pressure The patient then turns on his back and massage is repeated The objective is to bring the sponges into close contact with the gastric mucosa and with any ulcerative surfaces which may be present The patient then sits erect Gastric juice is aspirated by syringe through the tube after which the tube and sponges are withdrawn

Sponges braided silk and adherent mucoid particulate matter are immediately placed in a small bottle of 10 per cent formalin

The sponge and its absorbed contents are prepared for microscopy in the manner of other tissue

GASTROPHOTOGRAPHY

Color Photography Through the Flexible Gastroscope *Historical Note* Lange and Meltzung[105] described their attempt to photograph the interior of the stomach by introducing a small camera there attached to a rubber tube They did not succeed

Back Heilpern and Porges[106] with the same idea in mind developed an instrument which resulted in the construction of the so called gastro photor

The first acceptable color pictures of the interior of the stomach were reported by Henning and Keilhack[107] These photographs were obtained by the combined use of the *external* camera and the rigid gastroscope

Successful color photography was next reported with this combination by Gulzow[108] The pictures were taken in dogs with gastric fistula

The gastro photor consists of a semi rigid rubber tube fitted at its lower end with a minute camera which instead of lenses has light pin holes arranged vertically in pairs

The stomach is first thoroughly irrigated with warm bicarbonate of soda solution The contents are aspirated before the examination is undertaken

The examination is conducted in the roentgen ray room and after the metallic instrument has been passed its position in the stomach is noted under the screen It can be manipulated to rest in any part of the stomach

After the exposures the instrument is withdrawn the films developed magnified and then examined preferably stereoscopically

Photofluorography Roach, Sloan and Morgan[109] studied the advisability of quick and easy diagnostic procedures for large segments of the population for gastric lesions

The conclusion was arrived at that photofluorography was the most practical procedure

Patients over 40 years of age are now being examined in this manner at the Johns Hopkins Hospital Statistical data indicate that gastric malignancy will be found in 1 of every 700 men studied and in 1 of every 1200 women

The 70 mm Schmidt camera is used for photofluorography conducted without extreme irradiation of the patient This camera has a speed about five times greater than others previously used in photofluorography High speed is brought about by the use of a large spherical mirror which reflects light from the fluoroscopic screen directly on the photofluorographic film Because the aperture of the mirror is larger than that in the lens of the conventional refractor variety the degree of light brought to the film is greater than usual

The field covered by the photofluorographic screen is 15 inches square and the image on the film 55 mm square Owing to the fact that the screen-camera distance is 42 inches the camera cannot be mounted under a table Mounting the camera above a table was considered hazardous The grid and fluoroscopic screen (Patterson) variety E 2 are mounted directly below a horizontal roentgen ray table Light from the screen is directed downward on a front surfaced Pandro mirror whose surface is placed 45 degrees to the plane of the screen This mirror re-directs the fluorescent light into the Schmidt camera whose long axis is parallel to that of the roentgen ray table

The photofluorograph is powered by a standard 200 ma four valve generator operating at 95 Kv and controlled by a photoelectric automatic timer of conventional design Exposure times are of the order of 0 5 second A rotating anode tube with a focal spot 1 5 mm square is used and tube–screen distance is 36 inches

The imminent production of a new reflector variety of camera said to be capable of taking roentgenograms six times faster than previously possible in fluorophotography was announced lately by the Fairchild Camera and Instrument Corporation The new camera may well provide the tool needed to stimulate further mass survey work for cancer of the gastric tract as it may enable cancer clinics to make

gastrointestinal surveys with the same speed as the present tuberculosis survey mobiles which have done such a remarkable job" The new camera designed for fluorophotography of the thicker parts of the body, uses an extremely fast reflector variety optical system

Laboratory Data Laboratory data when evaluated in conjunction with clinical ones are often helpful

Gastric Analysis The information obtained is not in itself conclusively diagnostic except in those examples where malignant cells are demonstrated in the material withdrawn, however, when considered in conjunction with the history clinical examination and the results of other methods of investigation, it gives considerable assistance

(Achlorhydria or hypochlorhydria is found in approximately 90 per cent of patients suffering from gastric cancer, using histamine as a stimulant to gastric secretion)

Test Meals Several different meals have been used but the two main varieties are (a) the Ewald one hour meal, (b) the fractional meal

One Hour Meal This meal is taken in the early morning between eight and nine o clock Nothing is taken by mouth during the previous twelve hours The test meal consists of one pint of weak tea without sugar or milk and two small slices of toast (about two ounces) The patient takes the meal and in one hour the Ewald tube is passed By lowering the external end of the tube the gastric contents are removed by syphonage and collected in a suitable vessel (A Rehfuss tube may be used instead and the contents aspirated with a syringe)

Fractional Meal The patient takes his usual meal the previous evening at about eight o clock with a charcoal biscuit or two ounces of powdered charcoal at the end of the meal Nothing is taken after this The following morning at eight or nine o clock he swallows the tube When it is in position a record syringe of 20 cc capacity is attached to the end of the tube and all of the fasting contents of the stomach are aspirated and placed in a suitable receiver and kept for examination

When the stomach is empty the patient is given a pint of warm gruel which is prepared in the following manner two tablespoonfuls of fine breakfast oatmeal are mixed with two pints of water and allowed to boil slowly until the volume is reduced to a pint when it is strained through muslin When cool it is given to the patient to drink It is swallowed with the tube still in position The time is noted Every fifteen minutes the syringe is attached to the tube and about 15 cc of gastric contents or so much as can be obtained short of this amount is aspirated and transferred to a series of test tubes each bearing a label corresponding with the time that the contents were withdrawn from the stomach At the end of two and one half hours (if material can still be aspirated) it should be completely withdrawn and its volume noted The tube is then removed by traction

(The stomach is normally empty in two and one half hours)

The contents of the stomach obtained by aspiration before the meal is taken is known as the resting juice the examination of which is of great importance because it may yield valuable information

Fractional test meals with or without the administration of histamine may confirm the diagnosis by revealing a combination of achlorhydria with high total

acidity owing to organic acids but in some early examples the curve is within normal limits and occasionally is of the rising variety with an excess of free HCl

Examination of the fasting gastric residuum is of particular significance in the diagnosis of gastric carcinoma with pyloric obstruction Often the *quantity* of the overnight residuum is increased 50 cubic centimeters If the obstruction is great the amount of fasting content may be 1000 cc or more The amount of mucus is excessive in many instances Bile is often absent in severe obstruction

Bacterial flora usually shows some characteristic features—Boas Oppler bacilli and leucocytes

Exfoliated gastric epithelial cells may be numerous

The juice has an offensive odor in cancer of the stomach It may contain blood pus large amounts of mucus yeast cells Boas Oppler bacilli free HCl is usually absent and the total acidity above 50

Neither Boas Oppler bacilli nor lactic acid is pathognomonic of cancer however their presence usually denotes achlorhydria together with gastric stasis a combination of findings seldom occasioned by a benign tumor

Lactic acid is a product of bacterial activity Small amounts may be present whenever there is stagnation of gastric contents with deficient HCl as in many examples of dilatation of the stomach and chronic gastritis The presence of notable amounts of the lactic acid (more than 0 1 per cent) is strongly suggestive of gastric cancer and is probably the most valuable laboratory sign in the disease

In cancer of the stomach the characteristic finding is the absence of free HCl together with the presence of blood in some or all the specimens This achlorhydria occurs in over 50 per cent of patients The presence of free HCl therefore does not exclude a diagnosis of cancer while on the other hand the absence of free acid is not in itself diagnostic of malignant disease as it occurs in many other conditions as well as in a small proportion of apparently healthy adults

The presence or absence of free hydrochloric acid is dependent upon the degree of gastritis and the extent of the stomach wall involved by the growth Some degree of gastritis is always present While achlorhydria almost invariably characterizes advanced conditions free hydrochloric acid is frequently found in early conditions

The absence of HCl in chronic gastritis syphilis of the stomach pernicious anemia simple achlorhydric anemia and sometimes gallstones chronic appendicitis arthritis asthma etc is well known

Decrease of free HCl below 25 degrees (hypochlorhydria) occurs in some neuroses chronic gastritis early cancer pellagra and most conditions associated with general systemic depression Too low values are often obtained at the first examination and the patient s dread of the introduction of the tube probably inhibits secretion

In many instances gastric acidity is decreased *before* the appearance of gastric cancer as shown by Mandred W Comfort Mavis and P Kelsey and Joseph Berkson[119]

The majority of patients in whom definite ulcer-cancer can be proved give a relatively long history of digestive disturbance corresponding to the existence of the initial simple ulcer Whatever the level of gastric acidity shown in the test meals performed during this earlier phase the onset of cancer changes in the ulcer does not greatly alter it

The original ulcer and therefore the ulcer-cancer do not usually involve any

great part of the acid producing area of the gastric mucosa, and accordingly there is little or no tendency for the acid in the gastric juice to fall

This is in striking contrast with the result usually obtained in gastric cancer undergoing secondary ulceration With a much shorter history of digestive disturbance and a tendency to pyloric involvement this kind of patient usually shows definite changes in the test meal results as the condition advances The gastric acidity gradually falls, often so far as complete achlorhydria Coincident with this disappearance of free HCl, particularly if there is retention of food in the stomach, aciduric bacilli tend to develop freely with the production of lactic acid It is in this kind of patient that we may expect to find the large volume of foul resting juice which contains altered blood so characteristic of gastric cancer In true ulcer cancer although the resting juice may contain altered blood a foul specimen of very low or absent acidity is rarely found, unless the secondary carcinomatous change has been far advanced before the patient is examined Persistent altered blood in the resting juice of an ulcer patient whose earlier test meal results have indicated only intermittent bleeding i e, only during relapses should always be assumed to be attributable to malignant change

Microscopic Examination of Gastric Contents Little is to be seen under normal conditions except great numbers of starch granules with occasional epithelial cells yeast cells or bacteria

Under pathologic conditions remnants of food from previous meals red blood cells pus cells sarcinae and excessive numbers of yeast cells and cancer cells in gastric cancer may be found

Numerous bacteria are sometimes discovered especially in the absence of free hydrochloric acid The Boas Oppler bacillus is the only one of special significance It occurs in the majority of examples of gastric cancer and is rarely found in other conditions It belongs to the Bacillus Y bulgaricus group

Cytologic Examination This is best accomplished when other diagnostic means remain inconclusive

A negative cytologic diagnosis is of little significance because it does not exclude the possibility of cancer A positive diagnosis is significant

Limitations Gastric cancer is difficult to discover in smears unless one uses technics that almost amount to biopsies Gastric juice digests exfoliated cells and these even when undigested rarely show characteristic changes Then, again many of the growths are intra mural and do not exfoliate others are composed of signet ring cells which are characteristic enough if they are discoverable in smears (So far as the lower alimentary tract is concerned the results are better)

Materials Required

(a) Levin tube with a few additional openings cut laterally
(b) Fifty cc syringe
(c) Saline solution
(d) Centrifuge tubes
(e) Slides
(f) Fixatives

Technic

1 The tube is measured and marked
2 Patient prone
3 Tube passed either by way of nose or mouth
4 Stomach aspirated and material obtained placed in container
5 Saline solution (100 cc) placed in stomach through tube
6 Repeated washings of stomach with these solutions
7 Patient massaged laterally in various positions namely prone supine, sitting
8 Stomach again aspirated and material placed in second container
9 Gastric washings now transferred directly to slides and fixed

Papanicolaou and Cooper[111] described the technic of obtaining specimens by emptying the stomach with an ordinary Levine tube An equal volume of 95 per cent alcohol is immediately added to the aspirated specimen

The gastric juice is mixed so soon as it is obtained with an equal amount of 95 per cent alcohol

It is centrifuged *without delay* for 20 minutes at medium speed The excessive fluid is poured off The sediment is spread evenly on slides coated with a film of Mayer s albumen When the edge of the smear begins to show dryness slides are immersed in mixture of equal parts of 95 per cent alcohol and ether

The slides are fixed in alcohol-ether mixture for 20 minutes or longer Smears may be left in this mixture until ready to stain

The staining procedure is as follows

After fixation in alcohol ether the smears are washed in 80 70 and 50 per cent alcohols and distilled water stained in Harris hematoxylin diluted with an equal amount of distilled water for two to four minutes washed in distilled water, and then in running tap water for ten minutes rinsed in distilled water and run up through 50 70 80 and 95 per cent alcohols stained OG 6 (counter stain) for one half minute washed in 95 per cent alcohol (two changes) stained in EA 36 (counter stained) for one minute, (full strength or diluted) washed in 95 per cent alcohol (three changes) dehydrated in absolute alcohol cleared in xylol and mounted with cover slips

The staining technic is similar to that used in vaginal and other smears The cytology of the gastric fluid is unique in that many of the cells are derived from other organs The identification of cancer cells is facilitated by their abnormal traits the most characteristic of which involve the nuclei These are nuclear enlargements out of proportion to the size of the cells mitotic activation unequal fragmentation hyperchromatia and large and atypical nuclei The form and size of the cancer cells and the structure of their cytoplasm how considerable variations depending upon their variety and origin In adenocarcinomas the cells are more rounded and resemble adenocarcinoma cells from other organs Cancer cell may appear singly or in clusters [11]

Panico Papanicolaou and Cooper[11] devised and tested an ingenious inflatable abrasive balloon to obtain better diagnostic material (fig 49)

According to these investigators

The apparatus consists of a standard 16 French double lumen tube 100 cm in length with markings at 45 60 and 75 centimeters One lumen designated the aspirator is con

nected proximally to a syringe and distally to a patent silver plated bucket The other lumen designated the agitator is connected proximally to an inflating bulb and distally to an inflatable balloon

The balloon is made of a condom opened at both ends To the external surface are tied by single slipped bowknots approximately 250 pieces of untreated braided silk arranged in a regular pattern about 3 mm apart and cut to leave ends about 2 mm long The ends of the balloon are fixed to the tube by silk ties about 8 cm apart When the balloon is uninflated it collapses on the sides of the tube when it is inflated with 175 cc of air it measures 10 by 5 centimeters

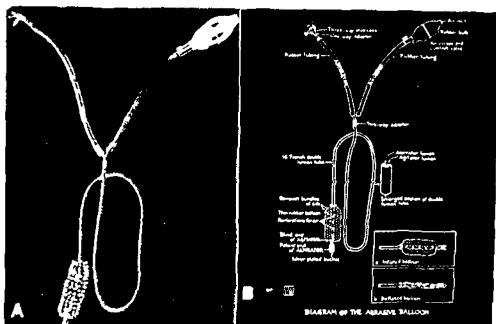


Fig 49 —A Inflatable abrasive gastric balloon apparatus B Diagram of the abrasive balloon apparatus (Courtesy Drs I G Panico C N Papanicolaou W A Cooper New York City and the Journal of the American Medical Association)

The authors advise that the patient be properly prepared by placing him on a liquid diet the day before the tests and carrying out gastric aspiration the night before

Technic

1 Dentures removed
2 Mouth cleansed
3 Deflated balloon moistened in Ringer s solution
4 Balloon passed by way of the mouth with assistance of small sips of the solution
5 *Balloon passed into stomach as the patient is instructed to swallow*
6 When tube is past the 60 cm mark the gastric residue aspirated and dispensed with
7 Balloon then inflated by 75 to 100 cc of air
8 Tube and balloon withdrawn somewhat to an extent to cause sensation of vomiting

9 Under screening reactive peristalsis noted carrying inflated balloon toward pylorus
10 Balloon deflated there so that it may project into the pyloric canal
11 Gradual inflation of balloon in the pyloric canal forces balloon to pass back into antrum
12 Balloon regressed toward cardia
13 Step repeated a number of times over period of an hour carrying the brushes over the entire gastric mucosa
14 Continual non forcible suction aspirator keeps gastric juice from accumulating
15 Balloon finally deflated and withdrawn
16 It is soaked in Ringer s solution
17 Fragments of tissue on silk brushes removed by cupped forceps
18 Material placed on slides prepared with a thin film of albumin
19 Slides placed in ether alcohol fixative
20 Entire balloon then replaced in Ringer s solution and shaken until all residual cells are detached into the medium
21 Specimens centrifuged for thirty minutes at 1500 revolutions per minute
22 Supernatant fluid decanted
23 Sediment covered with 95 per cent alcohol
24 Smears made
25 One slide stained by EA 65 modification as in diagnosis of pregnancy according to Papanicolaou
26 Three slides stained by methods still under study and as yet unpublished

The authors reported that the gastric cytologic study in 70 patients was confirmed in 33

(Malignant cells have several features in common They stain more deeply than do normal cells owing to the fact that the nuclei have a greater affinity for hematoxylin There are a greater number of degenerating cells than in normal tissues)

Another Gastric Washings Technic One technic in cytodiagnosis utilizing gastric washings is carried out as follows

Introduction of 30 to 60 cc of normal saline into a fasting stomach or following the multiple aspirations of an alcohol histamine meal as suggested by Richardson [113] He fixes the washings immediately in an equal volume of 10 per cent formalin This is followed by addition of a saturated aqueous solution of picric acid

The material was filtered slowly dehydrated and then handled as tissue Sections stained with a hematoxylin eosin and Orange G were studied from three different portions of the paraffin block

Screen Test for Malignancy The Black test as a screen test for malignancy was discussed by Nadler and Gordon [114] They believe it provides a valuable test for cancer

From 8 to 10 cc of whole blood is placed in brown bottles containing one drop of saturated sodium oxalate solution Samples are centrifuged and 1 cc of plasma is placed in each of two test tubes To the first is added 0 2 cc of 0 1 per cent of methylene blue solution to the second 0 2 cc of 0 1 per cent brilliant cresyl blue The tubes are then placed in boiling water The methylene blue container is observed

until the color disappears The time is noted Less than eleven minutes is considered normal eleven minutes or more indicates cancer

The cresyl blue specimen is boiled for ten minutes, then removed and the color noted Grayish tan is negative, lavendar positive Results are doubtful if lavender is not clear and methylene blue is decolorized in eight and a half to eleven minutes

Of 1513 patients without known malignancy 1194 or 79 per cent had negative results Cancer was indicated in 187 or 75 8 per cent of 247 proved cancers

Several tests for cancer are based upon changes in the plasma proteins The Bolen blood cell clumping appears to be positive in a large majority of patients suffering from cancer [115] A finger tip puncture is made The blood is placed on a glass slide and allowed to dry on a level surface When dry the blood from a healthy person appears homogeneous with central clumping of cells If cancer is present a lace curtain like pattern becomes visible after drying

The Modified Wright Stain Shu Chu Shen and Homburger[116] described a procedure for the preservation of cellular structure and the rapid detection of cancer cells in exudates by means of a modified Wright stain About 200 cc of freshly drawn effusion fluid is defibrinated in an Erlenmeyer flask containing 40 glass beads About 20 cc of defibrinated fluid is placed in each of two test tubes (5/8 by 5¾ inches) and centrifuged at 3000 revolutions per minute The supernatant is pipetted off and discarded The precipitate is then resuspended by gentle agitation in 2 to 3 cc of homologous serum or serum previously *adsorbed* by red cells of groups A and B This suspension is allowed to stand at room temperature for ten minutes it is then transferred to a smaller test tube (3/8 by 4 inches) and spun once more for five to ten minutes at 3000 revolutions per minute The supernatant is again withdrawn and discarded, except for a small amount of serum that is allowed to remain A drop of the precipitate is taken from the top layer of the sediment and placed on cover slips After drying the smears (preferably 3 to 6) are covered with Wright stain to which an equal amount of phosphate buffer of pH 6 4 is added after five minutes This is left for another five minutes The smears are then washed dried and mounted on a slide for microscopic study

The innovators of this technic maintain that it is superior to that of Papanicolaou

Blood Examination This reveals anemia to a greater or less extent, usually of a secondary variety

(Morley states that pernicious anemia is hardly ever associated with gastric cancer however it may be concurrent)

Slight leukocytosis is not uncommon

Owing to absence of intrinsic gastric factor there is megalocytic anemia It may thus resemble pernicious anemia

Blood in the Gastric Juice The benzidine test is the most commonly employed for the detection of blood in the gastric contents

In the presence of HCl the red cells are hemolyzed the hemoglobin being converted into acid hematin which is dark brown

Examination of Feces Examination of the feces for occult blood is usually positive and is then of value in doubtful instances in the latter persistence of blood in the stools after strict dieting and rest in bed for a week or two is sufficient justification for an exploratory operation

The stool may have a characteristic tarry appearance

The chemical test is performed as follows

The patient's diet must have been free from red meat for three days before the test A piece of feces as big as a large bean is mixed in a large test tube with water To this is added rather more than an equal volume of glacial acetic acid After mixing well the hematin is extracted by adding ether again rather more than the total volume of water and acid The tube is now thoroughly shaken and more water added The ether separates above and may be decanted off To this extract are added two or three drops of tincture of guaiacum and a little ozonic ether Blue at the junction of the liquids indicates a positive result As a confirmatory test the ether extract may be examined spectroscopically

The chemical tests give no clue as to the source of the bleeding but the spectroscopic test may help the presence of hematoporphyrin indicating as a rule that bleeding is from the upper parts of the alimentary tract Negative tests are strong evidence against cancer of the stomach

In gastric syphilis occult blood is usually present in the stools while in chronic gastritis it is usually absent

The chief value of the test is in exclusion Many factors lead to a positive result the value of a negative test is of much greater significance

In the case of chronic gastric ulcer if at the end of one month s strict medical treatment fecal blood is still present in undiminished amount operation should be advised without further delay

Resume

Differential Diagnosis of Gastric Cancer

History Symptoms and Signs

1 A long history is more likely to indicate a gastric ulcer a short one cancer

2 The short duration of symptoms even where the growth is extensive (and often inoperable) is among the most discouraging features of the disease

3 Almost any symptom referable to the abdomen may have its origin in cancer of the stomach

4 A change in time relations or character of ulcer pain is significant

5 Loss of weight weakness and rather severe anemia are presumptive of gastric cancer Anacidity favors the diagnosis of cancer and hyperacidity ulcer

6 Retention with evidence of stagnation is more common in malignancy

7 Hematemesis it must be kept in mind may occur in (a) peptic ulcer (b) varices of the esophagus stomach or duodenum (c) intestinal operations (d) ingestion of caustic substances (e) carcinoma sarcoma or polyps of the stomach (f) rupture of the stomach (g) passive congestion (h) yellow fever or malaria (i) chronic alcoholism (j) ruptured aneurysm (k) hemophilia (l) leukemias (m) tuberculosis (n) purpuras (o) portal obstruction (p) miscellaneous—nephritis post surgical bleeding jaundice syphilis

Cancer Site

1 The site of the growth is an important factor in diagnosis however a growth of the body of the stomach may reach a large size before producing symptoms while one at the pyloric end may produce symptoms of pyloric obstruction relatively early

2 The site and degree of invasion appear to bear *no proportional relationship to* acuity of clinical symptoms

3 Diagnosis is difficult in the insidious variety of cancer because of the vagueness of early symptoms Grow*ths found anywhere in the body of the stomach*—on the lesser curvature in the greater curvature, on the anterior or posterior wall in the fundus (in fact, in any part of the stomach except the pyloric vestibule the pyloric *canal and in contiguity with the cardiac* orifice) are commonly insidious They may not give rise to significant symptoms until the disease is extensive

4 When the cancer is situated in the pars cardia it may be observed fluoro scopically that the left leaf of the diaphragm is elevated and its excursion diminished The growth may then be visible as a shadow in the transradiant gas bubble as an irregularity of the normally rounded and symmetric dome, and as alterations of its internal relief pattern (These signs are best elicited with the patient standing for they are likely to be effaced in the Trendelenburg position formerly advocated)

5 By pressure on the lower part of the filled stomach the mucosa of the cardia can be limned with barium and thus inspected advantageously Marginal irregularity owing to carcinoma occurs more often on the internal border of the dome The apex of the heart at times casts a shadow over the gas bubble but the regular outline and pulsation of the shadow indicates its origin

6 A pyloric tumor must be distinguished from an enlarged gallbladder

7 Cancer arising from the body of the stomach is usually less mobile than a pyloric growth In either case the direction of local spread tends to be upward through the stomach wall towards the cardia Fixation of the body of the stomach to any *adjacent or contiguous structures in an advanced stage* of the disease may limit or prevent movement Large irregular masses may be palpated in the abdomen owing to direct infiltration of the omentum, mesentery and lymphatic glands

8 *Some leakage into the peritoneum from a simple gastric* ulcer may produce an inflammatory mass (perigastritis) which closely simulates a tumor of the stomach As a rule the mass is less firm and less movable owing to early fixation by tender *inflammatory adhesions A simple ulcer does not commonly* produce an abdominal tumor

9 Normally the transverse colon is situated below the stomach but occasionally it lies at a higher level posterior *to the stomach and when the colon* is distended with gas or intestinal contents it may produce pressure symptoms spastic con tractures and even resemble a filling defect on the stomach Similar abnormalities in the appearance of the stomach may *be produced by a distended* splenic flexure or descending colon

10 Spastic contraction of the antrum and pre pyloric area at times must be differentiated from gastric cancer

11 In pyloric obstruction there will be no bile in the vomit, but food is vomited Usually vomiting in this condition only occurs occasionally once every few days and often the vomit contains undigested *food of several days retention*

12 Kirklin includes gastrospasm and various extrinsic conditions among lesions to be differentiated from cancer and states that the deformity produced by cancer is persistent as to site and *configuration* withstands manipulation and remains unchanged at subsequent examinations while distortions caused by stimulants have none of these qualities

13. Pain may be of several varieties. In the presence of free HCl the pain is often indistinguishable from that produced by benign peptic ulcer because the mechanism is the same—acid irritation. In the absence of acid and peptic activity gastric cancer is painless until the tumor progresses beyond the confines of the stomach. The pain then becomes constant and is unrelated to the nature of the gastric contents. The pain is caused by malignant infiltration of the somatic as well as the splanchnic nerves.

14. In chronic gastric ulcer the main symptom is pain and next is vomiting. If the ulcer is near the pylorus and has caused pyloric stenosis pain assumes a new characteristic. In addition to the previous periodic pain relieved by food there is a griping felt across the epigastrium and associated peristalsis.

15. Loss of weight is almost an invariable symptom.

16. Gastritis may at times be confused with cancer on gastroscopic examination. Schindler (1939) reported seven cases of gastritis which presented a gastroscopic picture that could not be differentiated from cancer of the stomach and in which a final diagnosis was established only on microscopic examination. (The two conditions are frequently concurrent.)

17. Roentgenograms help in the differential diagnosis of cancer of the stomach from gastritis. In gastritis roentgenograms are not of much value in the differential diagnosis. There are localized ragged irregular hypertrophic mucosal folds or wart like granulation of the relief. These granulations appear as pinhead sized or diffusely scattered wart like growths. One of the most characteristic of the roentgenographic signs of gastritis is the appearance of mucosal erosions.

18. The variety of gastric cancer most likely to be confused with gastritis is linitis plastica. In this kind the difficulty is owing primarily to the fact that the lesion may involve the entire gastric mucosa and in consequence there is no normal mucosa present as a base for differentiation by the gastroscopist. A cancer localized in a gastroscopically blind area is obviously difficult to discover particularly in those examples where the growth is submucosal in origin and limited to a rather small area and where there is no associated tumefaction or ulceration.

19. The diffuse form of leather bottle stomach must be differentiated from

(a) Diffuse syphilitic infiltration of the stomach

(b) Diffuse hyperplastic tuberculous disease of the stomach

(c) The so called diffuse form of fibromatosis of the stomach

20. Atrophy of the gastric mucosa with or without pernicious anemia is considered a pre cancerous lesion by many surgeons and pathologists.

21. The vomit of gastritis contains mucus.

22. Chronic gastritis almost always is concurrent with cancer of the stomach and may improve under medical treatment even in the presence of cancer.

Differentiation Between Chronic Gastritis and Gastric Cancer

	Chronic Gastritis	*Gastric Cancer*
1	Occurs at all ages	Commonest after forty
2	Diffused pain after food	Pain more localized at all times
3	Morning vomiting	Vomiting after food coffee ground vomitus
4	No hemorrhage	Hemorrhage common
5	Free HCL often normal	Free HCL usually absent
6	Stomach often enlarged	Definite tumor palpable

In fibromatosis, which is considered to be a pathologic entity, an extreme fibrous thickening of the submucosa occurs, often in association with a chronic gastric ulcer Attention has been directed to tumor like appearance of redundant gastric mucosa and the production of 'filling defects' in the pyloric and duodenal areas caused by the prolapse of mucosa through the pylorus In recent years many authors have emphasized the striking similarity roentgenologically and gastroscopically between giant hypertrophic gastritis and cancer of the stomach Unusually large gastric rugae simulating cancer of the stomach are to be differentiated The significant features are maintenance of weight, absence of occult blood from the fece and the demonstration of soft pliable folds, decreasing in size with diminution of peristalsis or with insufflation of air

Indirect Signs of Gastric Ulcer

(1) Gastrospasm—this is the commonest indirect roentgenographic sign of gastric ulcer It is either circumscribed or regionary
(2) Associated gastritis
(3) Abnormalities in size, tone, peristalsis and rate of emptying
(4) Localized tenderness on pressure

The characteristic sign of a gastric ulcer consists of the demonstration of the ulcer crater—the "niche" of Haudek It consists of a protrusion of the barium shadow from the lesser curve The ulcer may be seen on the anterior or posterior wall When the stomach is filled with barium cream and the patient is erect, the crater is seen in profile and may be multifariously observed depending on its size depth and activity

In an active chronic ulcer the crater, filled with barium appears to be deep and often with a rather narrow neck and an everted margin

A healing chronic ulcer reveals (a) the ulcer is shallow and wide at the neck (b) the ulcer has somewhat a V shape

Ulcers at Special Sites

Pylorus The ulcer here is anatomically conditioned and consequently radiographic features are different from those in other parts of the stomach The ulcer partly enclosed in a muscular ring develops relatively little mucosal edema No deep crater is commonly seen if there is one it is to be observed as rather small and shallow

Fundus An ulcer here is uncommon and difficult of direct demonstration It requires fluoroscopy

Cardia At the cardia narrow protuberances of gastric mucosa may be seen in the lowermost part of the esophagus and at times, ulceration within them When this takes place spastic and cicatricial contracture of the esophagus also tends to take place The ulcer then is apparently in the lower esophagus

Microscopic Appearances On microscopic examination the appearance of any ulcer also varies according to whether it is active or healing

In the active stage there is a considerable degree of edema infiltration of the base and margin with leucocytes and evidence of an increased proliferation of fibroblasts The margins of the ulcer are seen curling over toward the base the muscular coats are entirely breached and the granulation tissue lining the walls of the crater shows engorgement with blood

When healing is in progress, owing to contraction which takes place in the scar tissue the size of the ulcer is diminished and there is up turning of the breached muscle ends The purulent exudate which covers the floor of the ulcer is absorbed the granulation tissue assumes a fresh healthy and active appearance There is subsidence in the venous and lymphatic engorgement around the margins leading to a flattening of the mucous membrane which creeps across the now rejuvenated ulcer bed

According to Schindler and Arndal[117] the signs in favor of benign ulcer are

1 Perfectly sharp edge without a surrounding wall
2 No infiltration of the mucosa
3 Hemorrhages and pigment spots lying in a normal mucosal localized gastric purpura
4 Henning s signs—arch shaped distortion of the angulus
5 Hour glass fold
6 Converging folds

The signs which are *not* proof of benign ulcer are

1 Normal mucosa distant from the ulcer
2 Uniform color of the wall and the surrounding mucosa
3 Mucosal islands within the ulcer

Signs in favor of malignant ulcer are

1 Limiting wall on one side and blending infiltration on the other side
2 Large tumor nodules and masses in the surroundings
3 Irregular ridges or nodes within the ulcer floor
4 Diffuse infiltration of the whole stomach even without visualization
5 White crystal like floating material of the ulcer floor
6 Location in the antrum close to the greater curvature
7 Visible ulcer in the pylorus
8 Bleeding at the edge
9 Dark color of the wall and pale surroundings
10 Bleeding edge
11 Ulceration in the walls surrounding the ulcer

The gastroscopic signs which are *not* proof of malignant ulceration are

1 Large size
2 Atrophic gastritis
3 Infiltration of the mucosa about the ulcer
4 Callous or edematous wall
5 Ragged edge
6 Hill like elevated area
7 Necrotic material on the ulcer floor
8 Regular nodes on the floor

Certain ulcerating gastric cancers may present the features of peptic ulcer This characteristic structure is attributed to peptic digestion of the cancer and adjacent tissues In such ulcers there may be notable or even complete repair of the tissue defect The scar of the ulcer may be covered by neoplastic mucosa or by a layer of epithelium perfectly normal in appearance

The following are the points in favor of malignancy

(1) A raised irregular edge
(2) An uneven base containing blood and necrotic tissue
(3) Irregularity or nodularity of the converging folds
(4) Raising of the whole ulcer above the surrounding mucosa

Differential Diagnosis of Peptic Ulcer and Gastric Cancer
Signs, Symptoms and Laboratory Data

Peptic	*Gastric Cancer*
Young adults as a rule	Elderly person as a rule rare under thirty years of age
Usually on lesser curve distant from pylorus	Usually near pylorus on lesser curve those on greater curve always malignant
Usually 2 cm or less	Usually more than 2 5 cm
Rarely a tumor	Tumor may be palpable
Hemispheric and sharply defined	Conical or irregular poorly defined meniscus effect common
Rugae converge corona and halo if seen en face	Rugae interrupted without convergence
Peristalsis tend to be active	Often diminished or absent
Motor function fair or increased	Motor disturbances
Pylorus spastic if any change the normal	Tends to gape
Heals	Enlarges or remains static transiently
Roentgenographic and gastroscopic evidence	Roentgenograms show defect gastroscopy may reveal growth
Symptoms of indigestion sometimes slight	Severe symptoms of indigestion anorexia especially for meats
Pain paroxysmal strictly localized soreness to touch in epigastrium sometimes painful spot over lower dorsal vertebrae	Pain frequently radiating may be referable to shoulder head and back often paroxysmal not infrequently severe
Pain in epigastrium transiently	Pain commonly aggravated by food
Tenderness present	Tenderness absent
Intermission of pain of considerable length	Pain rarely remits for any length of time
No edema	Edema of ankles common
Vomiting may or may not occur	Vomiting frequent symptom
Profuse hemorrhage common from stomach controllable more readily by diet and other treatment than in gastric cancer	Hemorrhage not very severe but frequently causes coffee ground vomitus Constant bleeding in small amounts more frequent than violent hemorrhage
Constipation usually intermittent occult or obvious blood in feces diarrhea exceptional	Constipation may alternate with diarrhea Occult blood in stools relatively constant
No fever	Occasionally slight fever of septic variety temperature sometimes subnormal
Loss of weight pallor and debility only if preceded by hemorrhage or dieting	Progressive loss of weight debility cachexia
No enlargement of peripheral glands	Enlargement of peripheral glands especially supraclavicular
HCl in excess in stomach contents	No HCl or low values
No lactic or fatty acid after Boas test meal	Lactic acid present after Boas test meal
Duration uncertain	Average duration one to one and a half years without operation may be shorter but seldom longer

Resumé of Differential Diagnosis of Benign and Malignant Gastric Ulcers

(1) Age Not of great diagnostic value

(2) Duration A long history is said to favor benign ulcer and a short one malignant but cancer may develop in a patient with chronic distress of other origin and conversely benign ulcer frequently gives a history of only a few month s duration

(3) Periodicity If the *same* distress has recurred at intervals for several years the probability of a benign lesion is greatly enhanced but malignant lesions if very slow growing may display asymptomatic periods Benign ulcer on the other hand may give no history of periodicity

(4) Relationship of the distress to meal taking with relief after taking food or alkali or following emesis is of no differential value for it is frequently encountered in cancer as well as in benign ulcer

(5) A *change* in the nature of the distress is often of considerable importance but this occurs in both lesions

(6) Loss of appetite loss of weight loss of strength coffee ground emesis melena and anemia may occur in both conditions

(7) Gastric analysis A diagnosis of chronic benign ulcer is *not* acceptable in the presence of *continued proved* (histamine) achlorhydria Cancer may occur on the other hand in the presence of normal acid values Large numbers of Boas Oppler bacilli are not seen in benign ulcer

(8) Stool analysis The continued absence of occult blood from the stool strongly denotes (but not positively) a benign ulcer whereas the continued presence of occult blood after two or three weeks of treatment speaks equally strongly for cancer

(9) Roentgenographic manifestations

(a) Ulcers of the greater curvature are almost always malignant

(b) Ulcers of the prepyloric or antral area likely to be malignant but many of them are not Pathologically the antrum is the favorite site for the development of cancer

(c) Size is of little practical value in the differentiation

(d) Benign ulcers usually give the appearance of extending beyond the normal confines of the gastric lumen whereas carcinomatous craters do not Exceptions however are not infrequent

(e) Tumefaction appearing as a halo about an ulcer crater may often be seen by the use of manual pressure in both benign and malignant lesions

(f) The meniscus sign of Carman[115] consisting of an ulcer crater located beneath the level of the lesser curvature and demarcated by a zone of tumefaction appearing as a halo almost invariably denotes cancer

(g) In benign ulcer the adjacent mucosal pattern is usually smooth except for folds radiating to the lesion Such radiating folds can also be seen in cancer but they are usually less numerous Parallel folds ending abruptly at the margin of the lesion are strongly suggestive of malignancy In neoplasm the mucosal pattern about the crater may be coarsely nodular

(h) Benign craters are usually smooth or slightly irregular malignant craters are often so but strikingly irregular or ragged craters are almost always malignant the irregularity being caused by the nodules about the margins

(i) Under adequate therapy the benign ulcer crater diminishes rapidly in size

10 Gastroscopic appearances The benign ulcer is usually craterlike rarely shallow

Spastic contraction of the antrum or of the prepyloric area may require differentiation from cancer This is equally true of large gastric rugae

CHAPTER VIII

Presurgical Preparation

The presurgical preparation of a patient afflicted with gastric cancer, is divisible into the psychologic and the physiologic

Psychologic Preparation

'In the treatment of the sick, *cheerfulness on the part of the physician is* abso lutely essential It behooves the wise physician to inspire the sick patient with hope of recovery even though he himself feels doubtful *of such a fortunate event* '

This teaching of Rhazes (A D 850–923) should be kept in mind above all, in the initial presurgical preparation of the patient

The psychic effects on him are manifested by fear, anxiety, insomnia, depression and irritability The patient's human environment includes a number of persons—relatives fellow patients, physician and nurses—all of whom may react not only on him but upon each other in regard to him

Hazlitt once said All things but our disorder and its cure seem less than nothing and vanity '

The surgeon in a parental role assumes responsibility He should instill confidence and imply that there is a probability of recovery

Older patients especially men are less emotional about their disease than women When the stage of resignation is reached the patient accepts any treatment carried out

Anxiety and fear concerning the anticipated surgery can be allayed by the use of *seconal (1½ grain) before operation or pentobarbital sodium, 1 to 2* grains intra venously

Palliative Treatment

Until the end of the 1930 s only palliative treatment was given for gastric cancer with 100 per cent mortality within one or two years *The palliation took the form* of either aiding swallowing by periodic dilatation of the esophageal growth with bougies *or the insertion of a food channel within the growth or a* final gastrectomy

In examples of inoperable cancer of the lower esophagus and cardia one or more of *five palliative methods are in* use namely

(a) Dilatation alone
(b) Radium bougie
(c) Deep roentgen ray therapy
(d) Souttar s tubes
(e) Relief of pain

About 80 per cent of patients with gastric cancer are beyond hope of cure by sur gery when they first consult a surgeon Many *other forms of treatment* including irradiation have therefore been tried in the past but without notable success

Some growths especially if they involve a great length of esophagus can be treated by a regular dilatation under esophagoscopy The dilatations are repeated at monthly intervals After dilatation an attempt can be made to bar the neoplasm from obstructing the lumen by inserting a radium bougie containing 80 mg radium for 22 hours This is guided into the involved area under fluoroscopic screening control The radium treatment may be combined with a course of deep roentgen ray therapy up to 5000 r

If dysphagia returns either from recurrence or from cicatrization after deep roentgen ray therapy and the patient s condition has worsened a Souttar s tube may be inserted The gravely ill patient is thereby enabled to swallow fluids and semi solids The tube can be easily cleansed by drinking soda water Roentgen ray control of the tube is important because some tend to slip and sometimes appear in the rectum

External irradiation is ineffective because of the deep situation of the gastric growth and its close relation to other vital organs both factors tend to bar adequate tumor dosage It is also ineffective owing to the high but variable radioresistance of gastric cancer cells Livingston and Pack[11] wrote that most patients do not survive long enough to benefit from prolonged external irradiation alone because of their eventual profound malnutrition

At the beginning of the century radium was believed to be a miracle substance in the field of cancer treatment

Implanted radium or any other radioactive substance has the clear advantage over deep roentgen ray therapy in that it gives the maximum dose of ionizing radiation inside the cancer and the circumjacent tissues receive less

Radiotherapy had and still has value in the treatment of squamous celled tumors, particularly in the cervical esophagus The difficulties in irradiating the intrathoracic tumors have encouraged attempts to implant radium needles or radon seeds through the esophagoscope or to introduce them on intra-esophageal carriers however these methods have so far proved not only ineffective but dangerous

Physical Preparation

Introduction Presurgically the patient must be studied to determine

(a) Presence or absence of obstruction
(b) State of hydration (The importance of sodium in water balance is fully appreciated today The bodily functional adjustments to imbalance of water —or electrolytes—are closely related to sodium metabolism)
(c) Electrolyte balance
(d) Body stores of protein (Patients whose blood protein levels are less than 6 5 mg per 100 cc are likely to have a delayed convalescence)
(e) Total daily caloric intake
(f) Vitamin intake especially of vitamin C (Patients with levels of less than 0 7 of this vitamin per 100 cc of blood are not considered good surgical risks)
(g) Presence or absence of anemia

The objectives of presurgical preparation are as follows

(a) To overcome dehydration
(b) To overcome toxemia
(c) To obviate so far as possible nutritional faults

(d) To overcome anemia
(e) To check bacterial activity
(f) To relieve distension, atony and congestion of the stomach

The patient is prepared but not confined to bed During the presurgical period he is given a high calorie fluid and semisolid diet with vitamins If there is no obstruction the diet is usually well borne, if there is difficulty in swallowing the stricture is dilated by means of bougies through an esophagoscope Solid food is not given for two presurgical weeks in order to reduce stagnation of food debris and sepsis The esophagus is washed postprandially with a drink of water or soda water

Treatment of course varies according to the general state of the patient, the local condition of the growth and the surgeon s experience

The mouth, gums and teeth have to be examined and treatment begun according to the condition discovered and the physical state of the patient Dental sepsis, it must be emphasized, favors the development of post anesthesia respiratory complications however, conservative treatment is in order regarding extractions in those who have difficulty in swallowing

The importance of good mouth hygiene at the time of esophageal and gastric surgery has been appreciated for many years Infection of the gums increases the hazard, as already stated of pulmonary complications and is usually associated with an unfavorable bacterial flora in the esophagus The extent of dental work to be done prior to surgical intervention is a matter of judgment

A mouth wash preferably of 25 per cent zinc peroxide should be ordered

A thorough physical and clinical examination is carried out with the object of evaluating with the aid of roentgenography and electrocardiography, associated physical abnormalities of the heart, lungs kidneys and other pathologic states

Next in sequence of clinical investigation are the various deficiencies caused by the gastric cancer namely blood conditions the state of water balance and nutrition Finally the local condition within the stomach and esophagus receives proper presurgical attention

Dehydration may result from (a) deprivation of fluids (b) excessive loss of water which may result from persistent vomiting prolonged diarrheas or the excretion of large quantities of urine or sweat especially when accompanied by a restricted water intake

The surgeon anticipates and prevents disturbances of water balance or treats their appearance so early as possible

Serious dehydration begins when water deficit amounts to about 8 8 per cent of the total body water that is 5 8 per cent of the total body weight If clinical signs of this condition are already present an amount equal to 6 per cent of the body weight should therefore be added to the other water requirements for the first day of treatment On making adequate allowance for all factors it is found that the dehydrated surgical patient often requires from six to nine liters of fluid a day during the first day or two of treatment

The clinical evaluation of the state of hydration is determined by the history and weight gain or loss by the physical examination—body temperature skin hydration tongue mucous membrane heart rate and blood pressure

For estimating the state of hydration of seriously ill surgical patients Drew *et al* [1??] recommended the use of the following three tests

1 Hematocrit determination of the proportion of cells to plasma in venous blood

2 The specific gravity of the plasma

3 The protein concentration of the plasma as calculated from the specific gravity of the plasma

Hematocrit the normal values are Males 46 per cent cells range 42 to 50 per cent Women 41 per cent cells range 39 to 43 per cent

Blood specific gravity males 10 566 daily range 0 0033

Blood specific gravity women 10 533 daily range 0 0033

Plasma specific gravity 10 270 daily range 0 0033

Plasma protein 7 0 Gms per 100 cc range 5 9 to 7 9 Gms per 100 cubic centimeters

Nursing notes concerning water intake and output are of primary importance Output should include not only a record of all measurable fluid losses but also notes of observations on less obvious losses such as perspiration and increased respiration

Prolonged loss of fluid produces the following changes in the blood

(a) Reduction in plasma volume
(b) Increased red cell count and hematocrit readings
(c) Increased concentration of plasma protein
(d) Increased viscosity of the blood
(e) Decreased sedimentation rate of erythrocytes
(f) Reduction in oxygen content of venous blood
(g) Increase in non protein nitrogen

Prevention and Treatment of Dehydration The problems confronting the surgeon in regard to fluid and electrolyte balance are essentially those of keeping volume of water and concentration of electrolytes at the optimum level

The normal person requires about 3500 cc of water daily 2000 cc for vaporization and 1500 cc for the urine It may be exigent however to supply a larger amount if the patient is losing large quantities of water by vomiting and other means In these events the replacement is based on the amount lost (if estimable) by the urinary output and by the signs and symptoms of dehydration A person weighing 150 pounds for example requires 4500 cc in addition to the 3500 cc given for daily need—or 8000 cc during the first 24 hours

Power *et al* [1 3] furnish simple rules designed to assist in administering parenteral fluids to surgical patients They are as follows

1 To restore sodium chloride lost prior to hospitalization give 0 5 gm of salt per kilo gram of body weight for each 100 mg that the plasma chloride level needs to be raised to reach the normal of 560 mg per centum

2 To maintain the normal sodium chloride level while abnormal gastrointestinal fluid losses are occurring give a volume of Ringer s or physiologic saline solution equal to the volume of gastrointestinal fluid lost If gastrointestinal suction drainage is instituted 1000 cc of Ringer s solution should be given during the first day to prevent a beginning depletion of body electrolytes Thereafter follow the volume for volume replacement but a minimum of 500 cc of Ringer s solution should be given each day of such drainage although the gastrointestinal fluid may be less than that amount

Glucose may be *given in a 5 or 10 per cent solution* Preferred in distilled water but may be given in saline Never give more rapidly *than 0 8 gm* Kg (one dram per *10 pound) an hour, this is the maximum rate of utilization*

(When dehydration is not present 1800–3000 cc *of total fluids* are adequate for the usual daily requirement, except for increased loss by *sweating*)

Methods of Replacing Fluid If the patient cannot take liquids by *mouth* replacement is by regulated parenteral path Maddock and Coller maintain that 80 per cent of *surgical* patients require only water and glucose, the former to sustain renal function and the latter to obviate ketosis and to save tissue proteins

Repeated records of urine output *must be kept They will ordinarily suffice* as an index for fluid replacement A urine output of 1000–1500 cc is fairly conclusive evidence of the absence *of dehydration If the specific gravity of the urine remains below* 1015 dehydration is not likely to occur, if there is no antecedent renal disease

Of course the best method of replacement is by mouth and *thirst is a definite indicator* of the requisite amount

When a patient is unable to take fluids by mouth intravenous therapy is best One thousand cubic centimeters are injected slowly every six hours Normal saline is the best substance

Probably the most practical measures for determining the total quantity of fluids that is needed by surgical patients is the one suggested by Coller and Maddock This is as follows

1 Water for urine (twenty four hours) 1500 cc
2 *Water for vaporization (twenty four hours)* 2000 cc
3 Approximate replacement of fluid loss in vomitus blood feces drainage from biliary and intestinal fistulae exudation from inflamed surfaces—variable In general replace blood with blood exudation with plasma '

For the dehydrated patient

4 Water to restore depleted body fluids (6 per cent of body weight estimated at 60 Kg —3600 cubic centimeters) '

The error and sometimes blunder of administering excessive fluids may be so serious as that of giving insufficient fluid *Patients with evidence of pulmonary edema should not be given large quantities of fluid*

Kidney *function* is usually *impaired* in severe dehydration It is one of the reasons that the administration of 5 per cent dextrose is required It aids in increasing plasma *volume and kidney blood flow*

According to Power Pederson and Maddock[131]

After a study to determine the value of two simple rules developed *for the administration* of proper amounts of salt sodium to surgical patients needing water and sodium chloride it was found that the replacement was *satisfactory in* patients of good or fair general condition who have suffered an acute or recent loss of gastrointestinal fluid Patients who had *a more chronic illness and* whose general condition was poor frequently failed to utilize the sodium chloride in a normal fashion more commonly depositing the salt and water in extravascular compartments and thus not increasing their plasma electrolytes to normal Less frequently they excrete the salt in the urine The additional *administration of salt to the* group in poor general condition was useless since it simply increased the abnormal responses To patients with the common factors setting the background for edema (generally malnutrition low plasma proteins severe hemorrhage profuse serious drainage severe renal or hepatic *damage) more than moderate* amounts of saline solution should be given with caution "

When using the intravenous route solutions of glucose stronger than 10 per cent are liable to cause thrombosis however, by using short bevelled 22 to 26 gauge needles 10 per cent glucose can be given at a rate of 9 cc or 100 drops a minute and a daily intravenous feeding of 3000 cc can be given in about five or six hours preferably in two installments

Parenteral feedings may be given subcutaneously intravenously and intrasternally

Intrasternal medication is a practical one for administration of casein hydrolysate or other amino acid preparations By this means 200 to 250 cc of amino acids can be given without pain

Fantus[125] made some excellent observations on the relationship of fluid administration to post surgical recovery as well as reporting the urine chloride test which now bears his name He noted that mortality increased when urine chloride was less than 0 2 per cent or when it was very high Marriott[126] suggested that a urine chloride equal to less than 0 5 gm sodium chloride per liter indicated that depletion and urine chloride equal to 5 gm sodium chloride per liter showed no depletion He stated that the measurement of sodium would be preferable to the measurement of chloride

Van Slyke and Evans[127] used the Fantus method of urine chloride determination as a guide to the detection of salt depletion and its correction They warned against renal impairment as invalidating the method and suggested giving saline solution if urine sodium chloride was less than 3 Gm per liter and dextrose in water if this concentration was exceeded

The best way to determine transfusion requirement is to evaluate the degree of hemoconcentration This can be done by determining the hematocrit, the serum protein the specific gravity or the number of red blood cells and hemoglobin

The hematocrit is the best single guide to blood needs but the red cell count and hemoglobin also are useful in estimating transfusion requirements Unless severe hemorrhage has occurred it is better not to exceed one liter of blood a day 500 cc a day usually is preferable Blood should be given daily until the hematocrit reaches the desired level at which it should be held by subsequent transfusions given as needed In patients with cardiac damage this level should be 40 to 42 in chronic debilitating diseases 45 to 47 is usually safe

The determination of hematocrit is made in the following manner Plasma is separated from the formed elements of the blood Whole blood with anti-coagulant added is centrifuged for 10 minutes at medium speed and 20 minutes at high speed The height of the column of packed red corpuscles expressed as a percentage of total height of a column of blood designates the hematocrit reading—for example if half of the column is red the hematocrit is 50 per cent The normal value is calculated by determining the volume of packed cells per 100 cc of blood in healthy persons on the basis of the red cell count of 5 000 000 cells per cubic millimeter The average values are men 45 per cent red corpuscles (range 40 to 45 per cent) women 40 per cent red corpuscles (range 37 to 47 per cent)

Salt Balance in the Body Water never moves about alone in the body but always carries salt with it and vice versa

The profound influence which salt concentration exerts on the properties of intra cellular fluids (and therefore on cell function) becomes evident when one considers

that the addition or subtraction of a little salt changes the boiling point freezing point, solvent power, electrical conductivity and many other properties of solution

After intravenous injection of saline solution the increase in water content of the tissues is greatest in the case of the muscles, skin and kidneys Since the muscles comprise such a large part of the body about 40 per cent of the body weight, they take up the greatest part of the added water (more than two thirds)

Normal saline or isotonic saline solution is possibly the best and the most generally used solution The solution is prepared by adding 40 grams of table salt to one pint of sterile distilled water

The glucose solution used in normal saline to which glucose has been added to the desired percentage is usually 5 per centum The amount of solution commonly used is one to two pints

The temperature of the fluid in the container should be about 120 degrees F and leave the tip of the needle at about 105 degrees F The solution should be passed into the vein at the rate of about 1 liter in from 15 to 30 minutes

Sodium chloride is lost along with the fluid in dehydrated states

In pyloric obstruction there is great loss of chlorides in the vomit, the remaining sodium radicles combine with the carbonic acid of the plasma to form an excess of bicarbonate and an increase in the alkali reserve of the plasma This is the dangerous state of alkalosis and the administration of sodium chloride is an urgent necessity

To calculate the amount of salt required two tests are of assistance

(a) If the vomit has been measured an equal volume of physiologic saline should be given intravenously to restore a normal level

(b) If the volume of the vomit is not known the blood chloride should be measured (normal, 575 mg per cent) Then an injection of 55 cc of normal saline per kilo of body weight is given for each 100 mg that the plasma chloride is reduced

In a ten stone (60 kilos) person therefore 3300 cc of saline are required for each 100 mg fall in the chloride

If as is usual, the degree of dehydration demands a larger quantity of fluid, saline should *not* be used to supply the remainder An excess of salt leads to water retention in the tissues and consequently to edema which will disturb the function of the lungs and hinder tissue healing One method of overcoming this risk is to substitute 5 per cent glucose solution for the normal saline after the requisite amount of salt has been given Another method is to use continuously a solution of one part of normal saline to four parts of 5 per cent glucose in distilled water

Though potassium within the cells may be replaced to a certain extent by sodium and though changes in chloride concentration are attended by a reciprocal alteration of bicarbonate content there is no substitute as previously emphasized for sodium Under these conditions the functional adjustments of the body to imbalance of water or electrolytes are closely related to sodium metabolism The elimination of sodium in the urine parallels the changes in body weight owing to changes in fluid content Sodium is important not only to sustain osmotic equilibrium in the body but also that of acid base balance

The pH of the body fluids is maintained with an amazing narrow range near 7 4

The alkalinity of body fluids is preserved despite the fact that the end products of the metabolism of foods are essentially acid Sodium represents the main defense against the continuous threat of acid formation

Sodium balance within the body is similar to water balance The normal daily intake of 3 to 10 Gm of sodium (8 to 15 Gm of salt) derived from food salt or condiments usually exceeds requirements and the surplus is excreted in the urine

The body saves sodium and chloride efficiently Fifteen hundred cubic centimeters of unavoidable daily water losses continue if all water intake ceases If all salt intake stops the kidneys conserve salt with great tenacity A negative salt balance occurs from abnormal losses of salt in alimentary secretions sweat or urine A positive salt balance may result from excessive intake of salt or interference with its kidney excretion For every 6 or 7 Gm of sodium chloride retained in the body it is estimated that one liter of water will likewise be held there

Potassium unlike sodium is secreted by the kidney despite a deficit Many patients are in a mild state of potassium deficiency at the time of surgical intervention

An adult may be given 3 Gm of potassium chloride every day provided there is no renal pathology

Timely use of potassium salts is important

Potassium deficiency may be corrected or prevented by the administration of potassium salt by the gastrointestinal intravenous or subcutaneous routes Rarely does a patient develop a potassium deficiency so long as food can be taken and retained Even with a restricted diet the use of orange juice and meat juice can supply an adequate daily intake of potassium Orally in addition Valentine s meat juice is given in a dose of one tablespoonful four times a day and supplies the equivalent of 5 to 6 Gm of potassium chloride

During treatment of patients with gastrointestinal diseases depletion of body protein must be considered whenever the patient cannot take food orally or loses large quantities of gastrointestinal secretions or has a potassium diuresis as a result of intravenous glucose in saline therapy or ACTH administration

Potassium is the chief cation of the intracellular space The average adult contains approximately 175 Gm of potassium of which 3 Gm is found in the extracellular space 8 Gm in the blood and 0 3 Gm in the blood plasma [1, 3]

The normal daily balance of potassium involves a turn-over of about 3 to 4 grams

The urinary output of potassium is significantly increased by the use of intravenous infusions of glucose and saline This may be sufficient to disturb potassium balance whenever nutrition is maintained by parenteral feeding alone Consequently the possibility of the potassium deficiency must be considered whenever oral feeding is not possible and parenteral therapy without adequate potassium content is used for more than a short period of time

The most common symptoms of potassium deficiency are drowsiness chronic ileus weakness with moderate abdominal distension anorexia nausea edema and oliguria

Laboratory determinations of the serum potassium and chloride levels are of value as well as the plasma carbon dioxide combining power

The serum potassium level test may not reflect accurately the status of intra

cellular potassium A low serum potassium has diagnostic significance and may be considered as an indication for potassium therapy Values of 3m Eq per liter or less indicate a considerable potassium deficit

Salt Block Excessive parenteral administration of salt solution may induce a condition called "salt block" This is characterized by edema, anuria and high temperature The administration of 5 per cent glucose in distilled water is specific

(Edema is not obvious clinically until the weight of the part of the body is increased 10 per cent over the normal weight by the excess edema fluid)

Malnutrition *A fundamental understanding of the problems of nutrition and an* application of the knowledge reduce surgical morbidity and mortality

*No dietary measures as such can overcome the weight loss of cancer of the stom*ach, however the patient should, if able to swallow, be sustained on a palatable, easily digestible, or predigested, diet with an adequate number of calories, proteins fat, carbohydrates and vitamins Those patients who have difficulty in swallowing for one reason or another receive food parenterally, aside from blood plasma

Proteins The maintenance of a certain concentration of plasma proteins is necessary for the continuance of life When the concentration falls below this limit death supervenes with symptoms resembling those seen in surgical shock

Protein stores in general and plasma proteins in particular have a vital role in establishing the normal relationships between intracellular and extracellular fluid

Little is known as to the manner and the means by which the protein content in the blood is sustained The regeneration time for serum protein is stated to be 3 or 4 weeks—about the same as for red blood cells In man the rate of renewal is 6 to 8 grams per day The globulins regenerate more rapidly than the albumins In diseases associated with reduction of plasma proteins it is the albumins that are first and chiefly affected so that they are the first to be withdrawn and regenerate most slowly

The globulins may be *increased* during the hypoproteinemic state thus giving a false indication of high total serum protein concentration

Abnormal loss of protein frequently occurs in surgical patients partly owing to the disease itself, partly on account of the surgical procedure

The most important factors which lead to a loss of protein in surgical patients are presumed to be

1 Anoxia
2 Shock
3 Hemorrhage
4 Loss of protein containing secretion from the wound fistula drainage formation of exudates and transudates
5 Ileus

The consequences of hypoproteinemia are

(a) Reduced resistance to infections and intoxications
(b) Increased propensity to edema
(c) Reduced gastrointestinal motility
(d) Retarded wound healing

According to Pack the patient with esophageal and/or gastric cancer is commonly admitted to a hospital suffering from (a) dehydration, (b) malnutrition, (c) hepatic

dysfunction, (d) nitrogen imbalance (e) loss of protein stores and therefore hypoproteinemia (f) deranged carbohydrate metabolism (g) hypoprothrombinemia

Protein is of paramount importance for those victims who have sustained a great loss of body weight

Estimates for protein and total caloric requirements vary according to the age and weight as well as with the duration of the disease It is easily possible to compute the patient s needs

The protein requirements may be outlined as follows

A person 132 pounds in weight divide by 2 2 to reduce to kilogram weight 60 kilograms of weight with allowance of 1 gram of protein per kilogram prescribe 60 grams of protein a day

There is no permanent harm in a high protein diet and the plasma protein of the blood does not appear to rise above normal The excess of nitrogen is excreted in the urine as urea and ammonia

The reserve store of protein in the adult body averages 4 5 pounds[179] In the hydrated state this protein may represent so much as 26 pounds a considerable part of the body weight

The body stores of protein are reflected in the level of the serum protein

Clinical edema which represents an increase of at least 10 per cent of weight by edema fluid usually appears when the serum protein level falls below 5 5 Gm per cent however incipient edema appears so soon as the serum protein level falls below 7 Gm per cent

Tissue growth and repair are dependent upon protein Hemoglobin is an important protein and the enzymes antibodies and hormones are protein products Protein affects water balance through its oncotic pressure as well as its participation in acid base balance and cellular proteins are not fixed after cell formation Continued regeneration requires new amino acids Both plasma and cellular proteins represent parts of a pool of circulating products for cell life

Ravdin and associates[130] first called attention to the necessity of protein replacement and the importance of an adequate caloric intake in correcting protein deficiencies in surgical patients

Among the metabolic abnormalities found in patients with gastric cancer a deficiency in the plasma albumin is as aforesaid outstanding Even when a strongly positive nitrogen balance is maintained (by a high intake of protein and protein hydrolysate) the plasma albumin level does not rise The low plasma albumin is found in many poorly nourished persons *The striking difference in patients with gastric cancer lies in their failure to regenerate plasma albumin while in strongly positive nitrogen balance*

Plasma protein as we have seen is essential in maintaining adequate osmotic pressure in the blood circulatory system If the plasma protein level is low any one of several of the following frequent complications may occur

(a) Decreased intestinal motility and distension probably caused by edema of the bowel wall
(b) Retarded wound healing
(c) Depressed kidney function

(d) Decreased resistance to infection owing to edema and to the fact that the antibodies are carried by the globulin fraction
(e) Decreased liver resistance to toxins
(f) Delayed emptying of anastomoses
(g) Increased incidence of bed sores
(h) Increased incidence of thrombosis
(i) Generalized debility, anorexia and slow recovery of strength

The most important result of protein deficiency is liver damage Casten[131] and others found that 77 4 per cent of 62 patients undergoing operation showed evidence of impaired liver function The effect of protein deficiency in this viscus may be two fold first, fatty infiltration with consequent cellular degeneration and second a patchy acute necrosis

The next serious effect *of protein deficiency is on the pyloric sphincter* Mecray *et al*[132] found that gastric emptying time in dogs could be delayed up to seven and a half hours by producing hypoproteinemia Ravdin[133] reported the history of a patient with pyloric obstruction, and with a twenty four hour barium residue in whom the plasma proteins were 4 8 Gms per 100 ml The stenosis was completely relieved in six days by restoring the plasma proteins to normal

Hypoproteinemia occurs with greater frequency in patients with gastric cancer than in those with other neoplasms or with benign lesions of the gastrointestinal tract

Apparently all sick persons or well persons except those who are severely under nourished and already in a state in which the excretion of metabolites of protein me tabolism exceeds intake, who are put to bed go into a phase of negative nitrogen balance *regardless* of protein intake

Pack wrote that hypoproteinemia is a common effect in esophageal cancer

> The protein depletion may be more marked than the plasma protein determination would seem to indicate In interpreting the report on the plasma protein level the state of dehydra tion of the patient must be borne in mind The correction of hypoproteinemia as well as the other nutritional deficiencies may require a week or two of pre-operative preparation A fluid diet or if feasible a soft diet high in protein carbohydrates and vitamins is given In some cases pre operative blood or plasma transfusions and amigen are indicated '

The manifestations of chronic protein deficiency are varied Chief among them is the gradual development of edema beginning in the dependent parts of the body and in the walls of the gastrointestinal tract which may be responsible for severe diges tive disturbances

Weight loss is common The loss of body tissue may be severe and the patient ac tually gain weight as a result *of retained water in the form of* nutritional edema

There is increased susceptibility to shock anemia weakness lassitude and anorexia

Chassin[134] states that

> Although a normal serum protein concentration does not indicate normal protein nutrition a subnormal serum protein level is good evidence of hypoproteinemia Normal values by the usual clinical method are total serum albumin from 3 9 to 5 3 grams per cent In order to

increase the value of these determinations it has been recommended that plasma volume studies be done routinely in combination with the serum protein determination so as to measure the total circulating plasma protein rather than the protein content per 100 cc of plasma

Chassin further wrote that "Whereas fat can be synthesized from carbohydrates and carbohydrates from protein the animal organism cannot fabricate protein from any class of food other than protein itself or of its digestion products the peptides and amino acids

Of the laboratory methods that may be used for diagnosis the most important is therefore the measurement of the plasma proteins especially the albumin fraction If the plasma albumin is below 3 5 Gm per 100 cc or the total plasma protein below 6 0 Gm per 100 cc a protein deficiency probably is present However the value for the total plasma proteins may be normal (as previously stressed) despite severe protein deficiency in the presence of hemoconcentration or an increase in plasma globulin such as occurs in certain infectious diseases

Treatment of Hypoproteinemia The patient is usually elderly and in varying stages of starvation making adequate pre surgical preparation exigent for prolongation of life

There are about five technics for giving the patient protein without using the stomach The easiest is plasma transfusion the next is intravenous administration of amino acid solutions the third is the nutrient enema the fourth orojejunal feed ings and the last gastrojejunal feedings as suggested by Bisgard[135]

Plasma continues to be used widely to replace protein lost from the blood Its chief advantage is its immediate effectiveness For chronic conditions and where the ur gency is not immediate the use of plasma to replace the plasma proteins is inadequate For example normal plasma contains about 7 grams of protein per 100 cc of plasma or 70 grams per liter thus it requires approximately two liters of blood a day to sup ply the minimum of 70 grams of plasma protein for the average size adult The use of protein hydrolysates as is shown further along is far less costly and more efficient

Prevention is of course better than cure

When a patient accepts food by mouth and does not tend to vomit he should re ceive a high calorie diet served at three regular meals and three or four times between meals

A diet containing at least 150 Gm of protein daily is indicated In very severe de ficiences as much as 300 Gm of protein daily is required This may be accomplished by a high protein diet supplemented by a palatable high protein drink For example

Whole or skimmed milk	1000 cc (32 ounces)
Skimmed milk powder	135 0 Gm
Pure casein	70 0 Gm
Sugar	20 0 Gm
Cocoa	20 0 Gm

Four glassfuls a day for a minimum of 100 Gm of protein or by commercial pro tein concentrate or protein hydrolysates The total caloric intake should exceed 2000 calories daily with supplementary vitamins

Young Abels Homburger Collier and Green[136] found the glucose administered by stomach tube to patients with gastric cancer is not transformed into hepatic gly

cogen and that this defective hepatic glycogenesis can be corrected by the administration of adrenal cortical extract

When a patient cannot take an adequate diet orally tube feeding is indicated A catheter is passed into the duodenum (under fluoroscopic control), if necessary A plastic, mercury weighted tube is best used because it is easily passed and well tolerated even when kept in place for a few days

Gavage feeding which may be ultra gastric or intra jejunal can be continuous by day and by night, or may be used intermittently during sleep

Tube Feedings in Gastric Obstruction Milk, cream, eggs, sugars and gruels are used in preparing liquid diets that can pass through the tube

Either glass or paper straws may be utilized The tube is placed in the side of the mouth and the patient is instructed to place the tongue over the tip when he stops sucking

Feedings of high carbohydrate, low fat value, used for some presurgical diets may be given by mouth or tube

Patients with little or no pyloric obstruction receive a limited amount of the following diets

Day Diet

2281 calories, 366 grams CHO 162 grams protein, 18 grams of fat

Ingredient	*Amount*
7 a m Gruel	10 grams
½ cupful (strained)	
Skim milk, ¾ cupful	6 ozs or 180 cc
Lactose, 2 tablespoonfuls	50 grams
9 a m Fruit juice	
Orange juice, 1 cupful	8 ozs or 240 cc
Dextrose, 1 tablespoonful	15 Gm
10 a m , Soup	
Skim milk powder 1 cupful	4 ozs or 120 grams
Skim milk 1 cupful	8 ozs or 240 cc
Puréed peas ½ cupful	50 Gm
Noon Fruit juice	
Orange juice 1 cupful	8 ozs or 240 cc
Dextrose 1 tablespoonful	10 Gm
2 p m Eggnog	
1 egg	
Skim milk powder ⅓ cupful	1 oz or 30 grams
Skim milk *1 cupful*	8 ozs or 240 cc
Dextrose 1 tablespoonful	15 grams
4 p m Soup	
Skim milk powder 1 cupful	4 ozs or 120 grams
Skim milk warm *1 cupful*	8 ozs or 240 cc
Green beans pureed ¼ cupful	50 grams
6 p m Fruit juice	
Grape juice 1 cupful	8 ozs or 240 cc
8 p m Eggnog	
Same as 2 p m feeding	

Night Diet

Portions 1½ 1000 cc. CHO 408 grams protein 114 grams fat 37 grams total calories 2428

Ingredients	*Amount*
Whole eggs	6
Egg whites	2
Skim milk powder	4 ozs
Lactose	300 Gm
Skim milk	1000 Gm
Salt	5 Gm

Frequently peroral administration of food rich in proteins is not feasible but in many such examples the objective can be reached by the oro-jejunal method suggested by Stengel and Ravdin They passed a Miller Abbott tube into the jejunum Through this they conveyed a mixture of peptone hydrolysate and dextrose by aid of an intermittent pressure pump In gastric resection they passed the tube through the newly formed orifice into the jejunum and were enabled to begin administration of protein-dextrose almost directly after the operation

An Abbott Rawson tube contains two compartments of unequal length The tube is passed into the stomach prior to the operation The end of the tube is passed into the jejunum at the completion of the gastroenterostomy The short compartment of the tube which reaches only to the stomach is used for aspiration purposes thereby keeping the stomach empty while food is introduced into the jejunum through the longer compartment (The material introduced is a protein glucose salt mixture)

Formula for Gastrojejunal Feeding

A Bring to a boil in a double boiler
 1000 cc (1 qt) milk
 400 cc cream (20 per cent)
 30 gm (heaping tablespoonful) lactose
 3 eggs
 3 additional egg whites

B Cool this mixture and add
 100 cc orange juice
 15 cc cod liver oil
 3 teaspoonfuls brewer s yeast

C Strain through a very fine sieve Serve 150 to 200 cc every two hours at body temperature

(This constitutes carbohydrates 110 proteins 69 fats 158 calories 2138 fluid 1760)

When the orojejunal method cannot be used it has been shown by Rhoades[117] and associates that peptone hydrolysate can be given by way of the rectum with resorption of a large quantity

If the patient finds part of the diet acceptable and tube feeding is required only for supplementary nourishment it is best to intubate him once daily Eight o clock in the evening is a desirable hour so that as much as 250 cc can be slowly injected into the stomach at one feeding and the tube withdrawn

If all nourishment must be given by tube for a protracted period the tube can be

left in place and liquid nourishment introduced in 75 cc amounts every hour, or 200 cc every three hours

(A preliminary jejunostomy is not commonly required but may be carried out if the obstruction is of so high a degree that oral feeding is impossible and preliminary gastrostomy—according to Pack—is to be avoided for any patient ' where the stomach requires mobilization at the time of esophageal resection ')

When parenteral alimentation or oro gastric feedings are inexpedient, a third means is available in jejunostomy It is now as previously stated, rarely utilized except when there is complete and possibly permanent obstruction of the upper part of the gastrointestinal tract There are, apparently, two contraindications Most of the feeding mixtures frequently cause diarrhea and abdominal cramps, the formulas are often complicated expensive and not readily preparable Other objections are the addition of one or more surgical procedures and the possibility of intestinal obstruction caused by fixation of the jejunum to the anterior abdominal wall

According to Stewart[138] the criteria for an ideal jejunostomy feeding mixture is as follows

(1) The mixture should contain an adequate amount of all nutritional elements (2) it should be inexpensive and easy to prepare (3) it should be easily digested and absorbed with low residue (4) it should drip easily by gravity (5) it should be relatively stable in the refrigerator for forty eight hours and (6) it should not contain too high osmotic or salt concentration

Homogenous milk is the ideal food for these patients By the second postsurgical day most patients tolerate so much as 2400 cc by jejunostomy providing 84 grams of protein and a total of 1680 calories thus obviating intravenous feeding

Parenterally protein is administered as whole blood plasma concentrated albumin protein hydrolysates or amino acids mixtures

The best and most rapid method of overcoming hypoproteinemia is by the use of plasma Usually 250 to 500 cc per day will bring about a satisfactory elevation of the serum protein level Occasionally larger amounts are needed Plasma has about 7 per cent protein and contains sodium chloride in the same concentration as physiologic saline the limit of utilization is therefore one liter (1 qt) a day

The principal disadvantages of plasma are the danger of homologous serum jaundice (unless irradiated by a special process) and the high cost of the material

Blood plasma has been largely freed of viruses by storage at room temperature for three months to two years

Salt poor serum albumin is an excellent source of protein Twenty five grams albumin per 100 cc solution is adequate in administering protein in small fluid volume and with low salt intake

(Volume for volume twice so much plasma protein is supplied by plasma as by blood Whole blood in contrast to plasma is used in general when the patient has lost whole blood Plasma on the other hand is used when plasma is the substance which has been actually lost)

Hydrolysates Proper mixtures of amino acids may be given by mouth by vein or by subcutaneous injection

From the work of Rose and others (J Biol Chem v 146 p 683 1942) it is gen

erally recognized that there are about ten amino acids which the human body is unable to synthesize at a rate sufficient to satisfy normal demands. Hence these amino acids must be taken into the body preformed in amounts sufficient to satisfy the needs of the body.

Commercial hydrolysates are derived from a number of protein sources.

Indications for parenteral feeding are inability to ingest, digest or absorb adequate quantities of food over such a period of time as to put in jeopardy the chance of an uneventful convalescence and which may even prejudice the chances of immediate postsurgical survival.

These predigested proteins are made by various methods, chiefly by enzymic or acid hydrolysis, from various proteins, an important one being casein.

(Protein hydrolysates can be prepared by treating proteins with (1) acids, (2) alkalis, (3) enzymes.)

Parenteral (usually intravenous) administration of a protein hydrolysate solution is often indicated (1) when the patient is unable to take food by mouth, (2) when complete rest of the alimentary tract is desired, and (3) when parenteral supplementation of oral food intake is desirable.

Although the complete digest of protein had been used for years as nutrients for bacterial growth, it was not until 1938 that a preparation of hydrolyzed protein was administered intravenously to human beings by Elman and Weiner (1939). Since then various protein hydrolysates have been given to patients both by mouth and intravenously.

There are two main products at present in the parenteral amino acid field. Parenamine (Stearns) is a 15 per cent solution of amino acids derived from the acid hydrolyses of casein and fortified with tryptophane. It provides 60 calories per 100 cubic centimeters. Parenamine is supplied in 100 cc. stoppered bottles, the contents of which are added to intravenous glucose solutions.

Amigen (Mead Johnson & Co.) is supplied as a 5 per cent solution of amigen powder in 5 per cent glucose solution or in alcohol.

In their informative brochure *Amigen*, Mead Johnson & Co. states:

> Not only does the administration of Amigen help in correcting protein deficiency, but it also aids in preventing further loss of body protein. The inclusion of dextrose in Amigen solutions is for the purpose of supplying calories and thus sparing the infused amino acids from being utilized for energy purposes. The water and minerals contained in amigen solutions help to meet the need for these essential substances. ... The nutritive contributions of Amigen solutions can be summarized then as nitrogenous constituents to be used in building protein, calories, water and sodium chloride and other mineral.

Mead Johnson & Co. furnishes the composition and analysis of Amigen. It is as follows:

Amigen contains all of the essential amino acid in the following approximate amounts:

	Per Cent		Per Cent
Leucine	9 1	Arginine	3 2
Valine	5 3	Threonine	2 9
Lysine	5 1	Methionine	2 6
Isoleucine	4 9	Histidine	1 9
Phenylalanine	3 9	Tryptophane	1 3

'The non-essential amino acids in Amigen are approximately as follows

	Per Cent		Per Cent
Glutamic acid	17 1	Alanine	4 2
Prolone	6 2	Hydroxyproline	1 5
Serine	4 9	Glycine	0 4
Aspartic acid	4 7	Cystine	0 3
Tyrosine	4 6*		

* Most of the tyrosine is removed by fractional distillation

'The average chemical analysis of Amigen is as follows

	Per Cent
Total nitrogen	12 0
Potential amino nitrogen	10 5
Amino nitrogen	7 8
Ash	5 5
Moisture	4 0'

'Amigen solutions can usually be given intravenously to adults at a rate of 3 to 10 cc. (45 to 150 drops) per minute Initially the infusion is often given at a slower rate, approximately 40 to 50 drops per minute, and is increased gradually in accordance with the tolerance of the patient It is customary to give Amigen solutions slowly to infants at a rate of about 1 cc (15 drops) per minute They may be given at a rate of not over 5 cc (75 drops) per minute to children

'Amigen 3⅓ per cent, Dextrose 3⅓ per cent in ⅓ Lactate Ringer s Solution can be given subcutaneously

According to Cassin

The various commercial protein hydrolysates differ from one another with regard to the raw material used (casein blood fibrin fish protein) and the method of hydrolysis (acid or enzymatic) The more commonly used products are amigen, an enzymatic hydrolysate of casein parenamine an acid casein hydrolysate aminosol, a partial acid hydrolysate of fibrin and travamin an enzymatic hydrolysate of bovine plasma At this time there is in sufficient comparative data to decide conclusively about the relative merits of these various hydrolysates Amigen and parenamine have been shown to be capable of maintaining nitrogen balance in human beings Mixtures of the essential crystalline amino acids have been used with success in man This agent rarely produces nausea or vomiting the experimental use of ossein gelatin in combination with hydrolysates has been reported '

The pH of most preparations lies in the region of 4 5 and it has been suggested that a solution neutralized to pH 6 5 is more satisfactory and can be used in greater strength [139] The solution, which must be free from pyrogens is given slowly, about one liter at a time over two hours the rate being adjusted to the reaction of the patient The untoward reactions which may be noted are nausea and vomiting from too rapid injection mild pyrogenic reactions and thromboses at the site of injection If intravenous medication forms the sole supply of food it is desirable to add vitamin concentrates to the fluid as well as carbohydrates It must be borne in mind that these hydrolysates are perfect culture media and great care must be taken to prevent bacterial contamination before use

(The protein hydrolysates when given parenterally sometimes diminish the patient s appetite They are then best given between meals preferably after the noon and evening meal)

According to Mead Johnson & Co Amigen

should not be administered in conditions in which there is abnormal retention of nitrogen in the blood the intravenous administration of any fluid in heart disease is potentially dangerous when intravenous alimentation is contraindicated for any reason intravenous administration of Amigen is likewise contraindiacted

According to Elman the definite contraindications to the use of protein hydrol ysates intravenously are

(a) Solutions which have been open for a few hours and are not crystal clear

(b) Allergic reactions—urticaria angioneurotic edema and skin rashes

Reactions to the use of hydrolysates are not common but when they occur are shown by chills fever nausea and vomiting Nausea occurs it is maintained owing to the glutamic acid content of the infusion

It is debatable whether postsurgical anuria is sometimes attributable to the use of protein hydrolysates intravenously

There is of course the general inadequacy of intravenous alimentation It is or dinarily impossible to administer adequate calories by the intravenous route

Homburger and Young[140] showed that hypoproteinemia once it is established in patients with gastric cancer postsurgically

> is persistent in spite of the administration of large amounts of protein adequate to result in significant increase of body tissue protein The investigation supplied evidence that inadequate intake and excessive loss of protein are not responsible for the persistence of the hypoproteinemia in gastric cancer patients after operation The conclusion is reached that either inadequate fabrication or distribution is responsible for the hypoproteinemia in gastric cancer The defect may be related to the gastrointestinal tract to the liver or to the adrenal cortex

The principal limiting factor in intravenous administration is fluid intake

The administration of 3000 cc of 5 per cent protein hydrolysate in 5 per cent glu cose solution gives the amounts of fluid electrolyte and nutrient material as shown in Table 3

TABLE 3

Fluid	Mineral as NaCl	Glucose	Protein Hydrolysate	Calories
3000 cc	6 0 Gm	150 Gm	150 Gm	1200

(Each 50 Gm of protein hydrolysate contains 2 0 Gm of NaCl)

One skim milk powder preparation has the following composition

Components	*Per Cent*
Protein	*37 8*
Casein	32 0
Lactalbumin	5 2
Carbohydrate (lactose)	49 7
Fat	1 0
Water	3 0
Ash	8 5

Varco[141] described the advantages of skim milk as follows

> Skim milk powder has a low cost is readily and widely available in quantity stores well in bulk and can be fairly well disguised in a variety of palatable mixtures The proteins

present are complete possess a medium capacity to induce plasma protein regeneration under experimental conditions and are rich in the liver protecting amino acid methionine they have repeatedly proved excellent sources when fed in quantity

The total volume of hydrolysate and the dextrose concentration must be varied to meet the requirements of a patient suffering from esophageal and/or gastric cancer The combined oral and intravenous supplementation usually 2 liters of 5 per cent amigen in 15 per cent glucose often provides a daily intake approximating 4000 calories and 200 grams of protein

For adequate evaluation of the protein nutritional status of the patient s progress under protein therapy the following procedures are necessary (1) daily weighing under similar conditions, (2) records of fluid intake and output (3) records of total nitrogen intake (4) determination of hematocrit and (5) plasma protein concentration determination by a Kjeldahl method

Rectal Feedings This is a valuable method for the introduction of water normal salt solution and glucose It can be given in quantities of 3 to 8 ounces every hour or two depending upon the age of the patient and the rapidity of absorption The solution should be warm Glucose should be given in 5 to 10 per cent solution—dextrose in ordinary corn syrup in water

If milk is given by this route it should be peptonized for 24 hours before use

Alcohol as an Injectant Moore and Karp[14] called attention to the caloric value of alcohol—intravenously administered—for patients suffering from inanition

Alcohol produces sedation and analgesia and has been used in conjunction with saline or glucose in order to reduce the need for morphine

Rice Orr and Enquist[143] contend that the experimental work carried out in regard to the energy value of alcohol has been without adequate consideration for carbohydrate and protein requirements

> If these nutritional elements are also taken into consideration it is very much more likely that alcohol can be substituted for fat calories without significant loss to the individual Investigative work concerning the bad effects of alcohol and other hepatotoxic substances have demonstrated that these undesirable effects cannot be reproduced when adequate nutrition is provided
>
> Our studies relative to the substitution of alcohol calories for glucose calories indicate an increase in the nitrogen output and a decrease in the nitrogen balance suggesting that alcohol calories alone cannot completely replace glucose calories'

Fat as an Injectant Intravenous administration of fat is receiving clinical attention Surgeons have been aware for years that solutions of amino acids and glucose did not have quite enough caloric value to maintain satisfactory nitrogen balance Since fat possesses twice so much caloric value as protein the advantage of a solution containing fat for intravenous administration is obvious[144] Recently Mulholland[145] and associates reported use of an emulsion containing cocoanut oil as the source of fat which seems to be free from reactions Their solution consists of 10 per cent fat 5 per cent glucose and 5 per cent protein hydrolysate Knox P 20 gelatin is used as a stabilizer This mixture is homogenized to obtain uniformity of the small size of the fat globules The solution contains 1300 calories for each liter

Saline as an Injectant Presurgical infusions of saline solution are indicated under various surgical conditions however sodium chloride deficiency is not so common in esophageal as in gastric cancer

Hypovitaminosis There is usually a deficiency of vitamins A, C and K in patients suffering from cancer of the gastrointestinal tract

Vitamin K The principal dietary sources are green leaves of plants especially spinach cauliflower cabbage lettuce egg yolk and soy beans

The protein deficiency is usually accompanied by vitamin deficiency and lack of vitamin C is especially important surgically because with protein it is closely related to the process of tissue repair

Lack of both vitamins may predispose to wound disruption not only of the laparotomy wound but also of gastrointestinal anastomoses It must be kept in mind that a surgical procedure in common with other forms of injury is followed by severe and rapid post surgical protein destruction and a dangerous nutritional level may quickly be reached if a patient already in a state of protein deficiency is submitted to operation

Vitamins C and K should be given separately The vitamins are best given in divided doses by injection into the rubber tubing three or four times a day This should be done near the intravenous needle

Anemia The cause of anemia associated with gastric cancer is uncertain because the incidence and severity of the anemia does not appear to be greater among those who show gastrointestinal hemorrhage than among those who are free of it Moreover prolonged administration of large amounts of iron and liver does not apparently change the blood picture to a great degree and in advanced conditions intravenous medication may also fail to do so Response to the medical treatment after resection of the growth may return to normal

The hematocrit and plasma specific gravity should be determined in order to obtain a better index of the degree of anemia present Red blood cells and hemoglobin determinations alone may give an erroneous impression because of hemoconcentration caused by dehydration

Transfusions are given if the hemoglobin is less than 80 per cent *after* dehydration has been corrected Five hundred cc of blood should be given daily and 1000 cc kept ready in the operating room

Use of Antibiotics Presurgical penicillin therapy is clearly indicated for those who are to undergo surgery for gastric and or esophageal cancer It is usually best to start administration twenty four to forty-eight hours prior to surgery unless there is secondary infection in or circumjacent to the tumor which indicates more prolonged pre surgical treatment

For six hours before operation penicillin lozenges may be given for oral antisepsis

Because of the frequent presence of ulceration in the tumor patients are given 300 000 units of penicillin intra muscularly with one half Gm streptomycin twice daily in addition to sulfadiazine 15 grain doses every 4 hours for 24 hours

Mechanical Gastric Cleansing Cancer of the esophagus is associated with various degrees of obstruction and there is consequently stagnation of food and secretions above the tumor which induce esophagitis Ulceration of the cancer may lead to secondary infection Pre surgical preparation of the patient for esophageal resection therefore includes cleansing of the esophagus above the tumor

The most effective method of determining the amount of obstruction is to insert a tube into the stomach through the nasal cavity eight or nine hours after a meal Any

amount of fluid over 100 cc represents obstruction If a few hundred cubic centimeters are found it is usually advisable to maintain decompression with a Levin tube through the nares for two or three days

If gastric obstruction is severe repeated gastric lavage with saline solution ameliorates the obstruction In high gastric or low esophageal obstruction it may be necessary to remove food debris from the esophagus through an esophagoscope

The night before the operation a Levin tube is passed to the area directly above the neoplasm and through it warm saline or boric acid solution is flushed past the growth The washings will either pass into the stomach or will return through the Levin tube If these irrigations are repeated twice daily for four or five days prior to operation a material change in the appearance of the ulcerating surface of the neoplasm will be noted Care should be taken that no aspiration into the lungs occurs owing to overflow from the obstructed esophagus Pre surgical lavage is *not* necessary of course, for patients with no esophageal retention

Immediate Presurgical Treatment The night before the operation a mild sedative (nembutal 1½ gr) is given and six hours prior to entry into the operating room all feeds are discontinued The stomach is washed and left empty One hour before operation a sedative is administered

The stomach must be kept clean and empty It is good practice to send the patient to the operating room with an indwelling Levin tube This is attached to the Wangensteen apparatus so that suction is maintainable during the surgical procedure Preparations are made for intravenous fluid administration

It is of great importance to order a fractional test meal before surgery In examples of hypochlorhydria the pre-operative treatment should include the administration of a 10 per cent HCl 10 to 16 minims diluted with water, three times daily It will be appreciated that the normal stomach contents are practically sterile owing entirely to the action of the hydrochloric acid

Preparation of the Small Intestine The main preparation of the small intestine consists in having it relatively empty for the operation This may be accomplished in three ways depending on the degree of stasis present If intestinal function is essentially normal witholding everything by mouth will usually insure the desired results Ordinarily a light evening meal is served and water is allowed until midnight

Another method of reducing the contents of the small intestine is continuous gastric suction The best method for aspirating the jejunal and ileal contents is by means of the Miller Abbott tube

One of the difficulties with the Miller Abbott tube is getting the bag past the pylorus It is often necessary to manipulate it under the fluoroscope and sometimes with the patient resting on his right side The best routine consists in inserting the tube into the stomach and having it advanced one inch an hour

Exercises Breathing leg and general exercises are ordered to prevent pulmonary or venous stagnation

Every effort must be made to minimize the possibility of lung complications Intratracheal insufflation of penicillin for a week prior to operation is of value

Preliminary Pneumothorax Now that intratracheal anesthesia has been developed to a high degree it is no longer necessary to study pressure differences in the thorax incidental to open thoracic procedures Preliminary pneumothorax is therefore un

necessary (The induction of a pneumothorax in preparation for esophageal surgery was customary in the past)

Somervell[146] states that

> Before transthoracic operations some operators like to give their patients an artificial pneumothorax on the left side (or right if the operation is to be on that side) in order to get them accustomed to breathing with one lung only or even with one good one and the other somewhat embarrassed If this is done the air is withdrawn the evening before operation
>
> Other operators dispense with this procedure and consider preliminary artificial pneumothorax unnecessary In any case breathing and coughing exercises are desirable before operations on the chest

An enema is given in the evening before operation or (if operated on in the afternoon) on the morning of the operating day

Preparation of the whole abdominal area including the lower part of the chest must be done 24 hours before operation

Blood grouping and RH factor studies are required as well as total protein and blood urea examinations

When emergency surgery is necessary—and it is seldom required—the surgical risk involved must be carefully weighed in operating on a poorly nourished patient or one with a failing heart against the danger of delay

On admission the patient receives one and a half ounces of castor oil if there is no pyloric obstruction or hemorrhage

Patients presenting themselves for operation fall into two groups—those in need of urgent operation and those in whom the operation is elective In the first group calculated risks are taken which are not justified in the second

Presurgical care depends on whether the patient is a good or bad risk In the latter class care is directed toward changing by various clinical means the bad risk to the good risk category

A patient for example who enters the hospital for gastric cancer without obstruction and whose hemoglobin is 12 Gm or better who has been eating well and has lost little weight needs no prolonged preparation for operation

It is for the poor risk patient that the following four points demand careful consideration water requirement electrolyte needs loss of blood and caloric and nitrogen requirement

Many patients are so ill or so advanced in the disease that no treatment other than simple medical care can be offered The preclusion usually is the extent of the growth presence of obvious metastases advanced cardiovascular disease and concurrent disease in other organs

CHAPTER IX

Anesthesia

Psychologic Preparation

The patient's fear may be aroused and intensified by unpleasant past medical and surgical experiences or they may be *exaggerated owing to the remarks of others* who have submitted to surgical operations similar to the one contemplated

It should be kept in mind that in the days of yore, before anesthesia was intro duced a surgeon was one who was pointed out in the streets with the same kind of shuddering awe or interest that now would be directed toward a public executioner

Persons who are afflicted with extreme nervousness anxiety and even terror, should be reassured in every possible manner They deserve kind, sympathetic and gentle treatment

If the patient is hospitalized, preparation for the surgery, the preliminary hypo-dermic injections the change of body apparel the trip on the stretcher to the operat ing theatre, the noise of instruments handled, all produce a variable reaction in many surgical patients

If the patient gives evidence, or complains, of pain during the operation, although *the common signs of analgesia are present, it is well to believe him* The analgesia may be incomplete

The objectives of pre medication are

(a) To make the patient comfortable surgically and psychically

(b) To lower metabolic activity thereby facilitating administration of inhala tion anesthetic or an analgesic agent

(c) To obviate untoward or unpleasant reactions

On the evening before operation nembutal, grain 1½ or 3 grains is given by *mouth* to provide good sleep On the day of the operation scopolamine (hyoscine) grain 1/150 with or without morphine sulphate is given *by hypodermic injection* one hour before the patient is brought to the operating theatre These drugs are of course *varied in amount according to the age and physical state of the patient* Elderly ones may be extremely susceptible to scopolamine and as a rule it is inadvisable to give the drug in extreme old age It may induce a rapid fall in blood pressure and collapse

The greatly apprehensive patient is usually put to sleep in his room *before* opera tion with basal anesthesia—either avertin rectally or intravenous sodium pentothal

An infusion may be started in the patient's room in the left arm and *preferably* with a No 18 needle in place

In some hospitals a balanced anesthesia is *customarily used* It consists in admin istration of sodium pentobarbital (nembutal), grain 1½ about two hours before opera *tion morphine sulphate grain* 1/6 or 1/6 and scopolamine or atropine grain 1/150 an hour preceding advent in the operating room

(Procaine and pontocaine mixed are used as analgesic agents—100 mg of procaine and 12 to 14 mg of pontocaine dissolved in 5 cc of spinal fluid The spinal analgesia is supplemented with 1 per cent sodium pentothal solution given intravenously and only sufficient to produce unconsciousness and to prevent vomiting during the operation)

General Problems in Anesthesia

About fifty years ago the first attempt to obviate the dangers of open pneumothorax during thoracic procedures was made by Quenu and Longuet when they invented and used their positive pressure apparatus Matas with the same object in view subsequently designed a machine for rhythmic inflation of the lungs

It is to Sauerbruch however that the main credit must be given for directing attention to the essential problems of thoracic anesthesia

The special difficulties are

(a) The poor risk patient Chronic invalidism is invariably associated with many thoracic operations (Probably the most reliable and ready means of estimating the cardiac and respiratory efficiency is the breath holding test of Sebrasez While resting in bed the patient takes one deep inspiration then closes his mouth, pinches his nose and holds his breath for so long as possible Any time exceeding 25 seconds is normal but less than 15 seconds indicates severe reduction of cardiac and respiratory reserve)

Patients who are to undergo thoracic surgery are usually poorer operative risks than the average and often advanced in years and with many organic deficiencies

(b) Paradoxic respiration This is one of the most dangerous complications of thoracic surgery Not alone does it affect respiration but it involves the cardiovascular mechanism as well

(c) Pulmonary secretion This is especially hazardous in thoracic surgery Efficient preparation of the patient by means of postural drainage and bronchoscopic aspiration should prove effectual

(d) The patient s posture The position of the patient on the operating table lying on the sound side impedes respiration and favors by gravity the passage of secretion from the infected lung into the sound one Careful arrangement of the patient is necessary with the head so placed that anesthesia may be safely administered

(e) Reflex disturbances The reactions produced are manifested by cough variations in respiration fall in blood pressure and deterioration in the patient s general condition

The choice of an anesthetic for an abdominal operation is governed by

(a) The age and physical state of the patient
(b) The kind and site of the disease
(c) The extent of the surgical procedure
(d) The surgeon
(e) The anesthetist

Of course the ideal agent for operations on the esophagus and stomach has not as yet been discovered

In upper abdominal operations the wound is made in the area in which respiratory movement is at its maximum so that it is desirable that the anesthesia should pro-

duce so little additional excursion as possible In order to obtain the best exposure the recti and other abdominal muscles must be completely relaxed This effect may be difficult to obtain owing to the fact that severe traction on the peritoneum and diaphragmatic attachments may result in reflex laryngeal spasm Then, again, sur gical trauma in the upper abdomen causes greater shock than is the case in the lower abdomen and pelvis And in general to be kept in mind is that prolonged operations upon upper abdominal viscera are often followed by more pulmonary complications than do those on other parts of the body

Physical Examination A preliminary physical examination should be carried out before the day of operation Estimation of the general condition of the patient is first in order in assessing him as an anesthetic and surgical risk Then comes estimation of the abdominal wall muscle tone Flaccid muscles, obviously, can be easily relaxed while a tight powerful body wall demands use of the most potent drug—curare, for example

Respiratory function requires special attention—cough for instance

The state of the blood, heart and vessels must be evaluated When the hemoglobin is below 50 per cent, or when the systolic blood pressure is less than 100 mm Hg high spinal analgesia, for example, is likely to be hazardous A low hemoglobin level may require transfusion before, during or after operation

Various technics of administration are carried out and several agents may be used either alone or in combination

In inhalation anesthesia an unobstructed airway is of transcendent importance This is best obtained in gastric operations, for instance by the passage of an intra tracheal tube either blindly through the nose, or under direct vision through a laryn goscope

Essentials of Effective Anesthesia Technics in Upper Abdominal Surgery

(a) Safety
(b) Good muscular relaxation of abdominal wall and peritoneum
(c) Minimal respiratory movements
(d) Protection from surgical shock
(e) Protection from circulatory disturbances
(f) Minimal disturbance of respiratory function
(g) Smooth induction
(h) Relative freedom from postsurgical sequelae
(i) Minimal interference with body chemistry

The methods of anesthesia for gastric operations are classifiable under two main groups (a) endotracheal anesthesia and (b) regional analgesia

The methods which appear to fulfill the requirements most closely are

1 Endotracheal nitrous oxygen-ether with subsequent hyper ventilation with car bon dioxide air If 5 per cent of the last named gas is added to inspired air the depth of respiration is immediately increased There is also a quick rise in blood pressure owing to a central action on the vasomotor center causing constriction of the arteri oles (An overdose of carbon dioxide is indicated by pallor low blood pressure rapid pulse fibrillary twitchings and rapid irregular breathing)

2 Spinal block (total gastrectomy with abdominal approach) best avoided

3 Field block of abdominal wall with splanchnic or mesenteric block or intra peritoneal use of procaine

4 Bilateral thoracic (6 to 12) and posterior splanchnic blocks, combined with infiltration of the line of incision The thoracic nerves are blocked at a point four finger s breadth from the midline The needle is felt to impinge upon the selected rib and is made to slide beneath its lower border It is then advanced not more than 1 cm and 10 cc of 1 in 1000 amethocaine solution are injected, the needle being kept moving backwards and forwards

(The last three methods can be effectively combined with an intravenous injection of a short acting barbiturate given just before the local block or by a very light cyclopropane anesthesia)

5 Curare When the surgeon reaches the peritoneum an initial dose of 10 to 12 mg of tubarine is placed in the intravenous drip

Inhalation Anesthesia

Nitrous Oxide Ether, Oxygen Many surgeons prefer general anesthesia in operations for cancer of the esophagus and/or stomach

To be considered are

(a) Selection of anesthetic
(b) Pre surgical medication
(c) Administration of anesthetic agent
(d) Supportive therapy during and immediately after surgery
(e) Treatment of postsurgical complications attributable to the anesthesia

The basic requirements for intrathoracic surgery are

(a) Maintenance of a free airway
(b) Clear view of surgical field
(c) Adequate supply of oxygen
(d) Adequate elimination of carbon dioxide
(e) Maintenance of anesthesia control at contemplated level
(f) Protection of circulation (adequate slow drip intravenous infusions and proper use of calcium gluconate)
(g) Control of reflexes (proper infiltration of dissection area and use of intra venous procaine if necessary)
(h) Constant awareness of the patient s condition
(i) Thorough operating room cooperation

Endotracheal Anesthesia The advantages of endotracheal anesthesia are

(a) Free passage of air
(b) Hazards of pulmonary complications diminished (aspiration of secretions for example)
(c) Control of laryngospasm
(d) Easy control of anesthesia level
(e) With open pleural cavity it is still possible to maintain intra pulmonary pressure with a high degree of safety

The to and fro carbon dioxide absorption technic is the method of choice An endotracheal airway is used for most patients It is desirable that the special tube

with an inflatable cuff be used By this means gastric contents which are occasionally expelled into the pharynx are easily removed with suction, while concurrently they are prevented from entering the trachea

(At the Memorial Hospital, New York City, endotracheal ether is the anesthetic of choice)

Endotracheal anesthesia, however, has some disadvantages which are owing to the insertion of instruments and tubes into the respiratory tract and the injury possibly resultant from this maneuver—for example, inducing granulomas of the vocal cords rhinitis, pharyngitis and laryngitis

The esophagoscope is first passed and suction carried out As the instrument is withdrawn a tampax pack is inserted through it to rest in the gullet just below the cricoid It is then fairly certain that there will be no reflux of septic fluid from the tumor, or from the esophagus itself into the pharynx which can be inhaled during the early stages of surgery

The nasopharynx is then cleansed by passing a well greased No 10 rubber catheter through each nostril and applying suction

A pharyngeal airway is then introduced and as a further precaution against inhalation of secretions a light pack is inserted around this

At the termination of the operation complete inflation of the lungs is accomplished while the thorax is still open and this effect is maintained until the thorax is air tight except for a sealed underwater drain

Before the position of the patient is altered the pack is removed from the pharynx The nasopharynx is again cleaned through a soft rubber catheter placed in turn through each nostril The tampax pack is removed from the upper end of the esophagus by traction on its silk thread over a finger inserted in the pharynx

Through the esophagoscope fluid or blood clot is aspirated from the gullet

Continuous oxygen is given by nasal catheters after the patient returns to the ward and the blood drip is kept going slowly

Cyclopropane Anesthesia Cyclopropane was first suggested as an anesthetic agent by Henderson and Lucas (1929) and its clinical use was established by Waters and Schmidt (1934) and Bourne (1934)

The gas is produced by the reduction of trimethylene bromide in the presence of metallic zinc in ethyl alcohol

It is a colorless gas heavier than air, and has a faint benzene like odor It is relatively inert chemically is insoluble in water but readily soluble in lipoids

Cyclopropane resembles ether in its anesthetic action but is less irritating to the respiratory tract It produces stable anesthesia with quiet respiration but does not require the use of so much oxygen as with ether

Cyclopropane slows the heart and sometimes produces arrhythmia

R M Waters[14] wrote that pre medication is to be given in *small doses* when this anesthetic agent is used Induction should be by nitrous oxide and oxygen with rapid addition of cyclopropane to the mixture In the average patient the oxygen tension should not be more than 20 per cent because accumulation of carbon dioxide caused by hypoventilation may be overlooked Waters called attention to the little time interval between actual abdominal relaxation and respiratory paralysis Owing to the

high percentage of oxygen used cyanosis does not appear in consequence of depressed respiration

In the premedication some anesthetists administer an ordinary dose of hyoscine and others prefer the use of avertin

Apparatuses for anesthesia and for administration of cyclopropane have the following essential components (a) a flow meter graduated to deliver so small a volume of cyclopropane as 50 cc per minute with an oxygen flow meter graduated at 100 cc per minute, (b) a re breathing bag (c) a close fitting face piece (d) a soda lime canister for carbon dioxide absorption

Variable quantities of cyclopropane according to the individual anesthetist are added to the re breathing bag half filled with oxygen Third stage anesthesia is reached in one to five minutes

For maintenance of anesthesia the following technic is customarily used through out the operation the patient receives 250 to 300 cc of oxygen to meet his metabolic requirements and either a constant trickle of 50 cc of cyclopropane is given or 100 cc of cyclopropane is added for two or three minutes at intervals during the operation After induction cyclopropane should not be added at a faster rate than 100 cc. per minute lest a too sudden increase should cause apnea

A concentration of 4 per cent will produce analgesia 8 per cent light anesthesia 20 to 25 per cent moderate anesthesia and 40 per cent respiratory failure The gas is explosive in anesthetic concentration of less than 15 per cent.

During the maintenance stage respiration is quiet and shallow The deep reflexes are active Slowing of the pulse below 60 is a great danger signal An irregular or rapid rhythm is an indication to stop the flow of cyclopropane

The anesthetist must be circumspect in the administration of cyclopropane because of its potency in low concentrations the absence of respiratory stimulation and the dangerous concentrations that may be reached before receiving timely warning afforded by cyanosis or laryngospasm A slow induction a gradual deepening of the anesthesia when necessary and a close scrutiny of the patient are all essential

Skeletal muscles are relaxed but anterior abdominal muscles only at times If relaxation is not adequate and respiration is becoming depressed it is best to add a little ether vapor If there is difficulty in regard to relaxation some kind of regional block should be induced

Advantages of Cyclopropane in Thoracic Surgery

(a) It produces quiet uneventful narcosis
(b) Asphyxia does not occur owing to the lower concentration at which it is used
(c) It provides adequate oxygenation
(d) It does not irritate the upper respiratory tract
(e) The anesthetic effects are rapidly reversible
(f) Shocked patients tolerate it extremely well
(g) It has little or no effect on metabolism
(h) It can be used with some ether (one ounce) to counteract some undesirable features

Disadvantages of Cyclopropane in Thoracic Surgery The disadvantages are its

explosiveness, depression of respiration, uncertain power of producing muscular relaxation and its sensitizing effect on the cardiac automatic conductive tissue There is an occasional danger of atelectasis because of reduced pulmonary ventilation The addition of small quantities of ether vapor greatly aids relaxation, while it minimizes cardiac irregularity

"While it has certain disadvantages," wrote Siese (1937) it more nearly approaches the ideal inhalation anesthetic than any other drug which is available at the present time"

It has been shown that circulatory complications which may persist in the post surgical period, such as tachycardia alteration in the blood pressure or cardiac arrhythmia or shock are more frequent after cyclopropane than after ether even in healthy persons[148]

On the other hand the respiratory morbidity is less than with ether or spinal analgesia[149]

Indications for and Contraindications of Cyclopropane in Thoracic Surgery Cyclopropane being non irritant to the respiratory tract makes the ideal anesthetic for thoracic surgery

Because cyclopropane is administered with a high percentage of oxygen it is the ideal anesthetic today for patients suffering from cardiac decompensation, in blood diseases, in diabetics, in hyperthyroid conditions and in severely shocked or toxic patients

Contraindications (a) When diathermy or cautery is to be used (b) cardiac arrythmias and laryngospasm, (c) as a rule when Adrenalin is to be used

The Use of Curare This is a crude extract of Strychnos and Chondrodendron tomentosum The terms "tube," gourd and "pot" curare refer to the varieties of containers used by the natives in carrying the crude preparation to market Tubo crurarine is carried in bamboo tubes

Two brands are on the market, Intocostrin (Squibb) and Tubarine (B W & Co) Tubarine is a buffered solution made up so that 1 cc contains 10 mg of d tubocrurarine ($C_{38}H_{44}N\ O_6Cl_2$)

Each cubic centimeter of d tubocrurarine contains 3 mg of the drug It was early estimated that approximately 0 15 mg of d tubocrurarine hydrochloride pentahydrate per kilogram of body weight produces a standard response termed a unit

Curare acts by interrupting the nerve impulses to the skeletal muscles This interruption occurs at the myoneural junction and is probably owing to interference with local action currents or the acetylcholine mechanism of transmission

It affects the various muscles of the body in the following order first those innervated by the cranial nerves, second those of the trunk and extremities, third, those of respiration fourth those of the diaphragm

There is no effect on heart action except as may result from apnea and from lowered blood pressure The smooth muscles of the vascular system are not affected

Used in anesthesia the drug gives maximum relaxation of musculature and viscera with a minimal degree of anesthesia Takehany[150] showed that with the use of curare the amount of nitrous oxide required for a surgical operation may be reduced to a large extent thereby permitting an increased oxygen exchange Then too with the

use of curarelike drugs smaller doses of local analgesic injectants can be used effectively

Regional Anesthesia

Regional anesthesia may be used alone or together with light general anesthesia to improve relaxation and to decrease the amount of requisite general anesthesia It may also be accomplished by (a) abdominal field block (b) posterior intercostal block, (c) lateral intercostal block (d) or rectus sheath block Without general anesthesia splanchnic block is additionally required

Regional analgesia is the method of choice in poor risk patients

To be effective in the upper abdominal wall bilateral blocking is necessary of the lower six dorsal nerves (which carry both motor and sensory fibers) Analgesia of the upper abdominal viscera requires blocking of the splanchnic plexuses The dorsal nerves can be reached in their subcostal grooves four finger breadths from the spinous processes or in the mid axillary line Five to 10 cc of analgesic solution are injected into the vicinity of each nerve

Spinal Analgesia

Advantages The advantages of spinal analgesia according to some surgeons are

(1) It reduces nervous apprehension that some patients have to losing consciousness

(2) It is useful for prevention of shock and can be utilized with advantage for severe prolonged operations

(3) It gives extreme muscular relaxation

(4) Danger of asphyxia or thoracic complications from inhalation of vomited material is avoided

(5) Straining and heaving are not present

(6) Hemorrhage is much less because of the lowered blood pressure

(7) Retention of consciousness mav be an advantage in case the patient has to be consulted about some matter in his previous history

(8) Where an experienced anesthetist is not available

(9) In great abdominal distension it is invaluable

(10) Where a general anesthetic is undesirable for any reason such as nephritis diabetes chest diseases certain heart affections such as mitral stenosis and the presence of an enlarged thyroid gland

(11) The method is indicated in strong muscular patients and in some with active pulmonary tuberculosis bronchiectasis or acute bronchitis Analgesia may reach to the fourth or fifth dorsal roots so that the spinal nerves supplying the skin and muscles of the anterior abdominal wall may be blocked as well as the rami communicantes carrying visceral impulses from the upper abdominal organs The higher the level of analgesia the greater the risk of circulatory depression and post surgical pulmonary complications Traction on the stomach and mesentery may cause nausea and retching by reflexes involving the vagus nerves and for this as also for psychologic reasons it is desirable to combine light general anesthesia with the high spinal block

The analgesic solution diffusing itself through the cerebrospinal fluid acts upon

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(11) The method is indicated in strong muscular patients and in some with active pulmonary tuberculosis bronchiectasis or acute bronchitis Analgesia may reach to the fourth or fifth dorsal roots so that the spinal nerves supplying the skin and muscles of the anterior abdominal wall may be blocked as well as the rami communicantes *carrying visceral impulses from the upper abdominal organs The higher the level* of analgesia the greater the risk of circulatory depression and post surgical pulmonary complications Traction on the stomach and mesentery may cause nausea and retching by reflexes involving the vagus nerves and for this as also for psychologic reasons it is desirable to combine light general anesthesia with the high spinal block

The analgesic solution diffusing itself through the cerebrospinal fluid acts upon

all *exposed* nerve tissue and inhibits its conductivity—the maximum effect being exerted upon the spinal nerve roots rather than upon the cord itself The cord is less involved as it is protected by the covering pia mater so that it is only affected superficially and continues to transmit nerve impulses and impressions between s ments

It is to be recalled that cerebrospinal fluid comes into contact not only with t spinal roots, but with those of several of the cranial nerves when it passes to th level, namely the optic, motor oculi, trochlear and abducens

The spinal analgesia is supplemented with 1 per cent sodium pentothal soluti given intravenously and only sufficiently to produce unconsciousness and preve vomiting during the operation

Every effort is made to prevent or correct a prolonged fall in blood pressu Ephedrine sulphate, in doses of 25 mg to 50 mg , depending upon the *diastolic* pre sure is used If the diastolic pressure is over 100 mm Hg the smaller dose is giv and the larger dose is used for those patients whose diastolic pressure is less tha 100 mm of mercury

If, in spite of all care the patient remains uncomfortable and miserable the inhal tion of cyclopropane is started at once This gas should also be used where possib if a supplementary anesthesia is necessary owing to the premature wearing off c the analgesia The excess of oxygen which is the accompaniment of cyclopropan administration is particularly beneficial to spinal block [151] A very light narcosis ca also be obtained by adding at intervals small doses of soluble thiopentone to a intravenous drip saline [15]

Toxic symptoms are not owing to the fixation of the drug in the lipoid element of the synapses but to absorption of the drug from the cerebrospinal fluid into th systemic venous circulation

Disadvantages of Spinal Analgesia

(1) Retention of consciousness
(2) Position of the patient may be undesirable
(3) Uncertainty of analgesia
(4) Cannot be used for very high operations—that is, above the level of the third dorsal segment
(5) It should not be used under the following conditions
 (a) Severe shock, especially wound shock
 (b) With very low blood pressure
 (c) In feeble old people
 (d) In pyemia or skin sepsis
 (e) In meningeal disease
 (f) In pregnancy
 (g) In thoracic conditions such as bronchitis, bronchiectasis and edema of the lungs a very high spinal should not be given but an ordinary low spinal is not only permissible but may be advantageous

It has been shown of late that there is a large increase of blood and spinal fluid sugar in spinal analgesia It is then obviously important when surgery is carried out on a person suffering from diabetes to avoid the use of intravenous glucose without prior estimation of the sugar level and use of insulin

Contraindications to Spinal Analgesia Spinal analgesia should not as a rule, be used for patients who have abnormally high or low blood pressure or who have suffered from any disease of the central nervous system High spinal blocks should be avoided if the patient has any form of respiratory obstruction or other interference with normal respiration and never if there is sepsis in the area of the contemplated lumbar puncture

Difficulties in Administration of Spinal Analgesia

1 Failure to enter theca
 (a) Osteoarthritis
 (b) Obesity landmarks frequently difficult to find
 (c) Inaccuracy of direction
 (d) Blunt needle
 (e) Passing directly through dural cavity and onto bone
 (f) Antecedent sclerosis of meninges from disease
2 Failure to get good flow
 (a) Patients in extremely poor physical condition
 (b) Particle of skin a fold of arachnoid or a nerve cord entering needle eye
 (c) Entering side of theca
 (d) Blood clot in needle
3 Failure to get adequate analgesia
 (a) Poor flow of cerebrospinal fluid
 (b) Incorrect injectant
 (c) Inadequate dosage
 (d) Improper technic

A technical point which is well to keep in mind when spinal analgesia is induced is the careful notation during subarachnoid tap of the pressure and rate of drip of the cerebrospinal fluid If fluid drips very slowly even though it can be aspirated freely the anesthetist should be particularly careful in the use of single dose spinal analgesia because the slow dripping of the fluid usually forecasts a rather sudden fall in blood pressure if the contemplated original dose is injected It is best then to diminish the dose by 15 per cent

In certain patients having a low systolic blood pressure and therefore a low spinal fluid pressure it may be difficult to withdraw 6 or 9 cc of spinal fluid Physiologic saline solution can be substituted as a diluent for the procaine

Position of Patient in Lumbar Puncture This is an extremely important factor in successfully accomplishing a lumbar puncture

The vertical position is advocated by some surgeons The patient is seated with his legs dangling and the back strongly flexed A nurse or other assistant stands in front of the patient in order to support him This position of course cannot be kept when the patient is unconscious or gravely ill

The lateral position on a flat topped table has greater advantages It is utilizable in all instances

Monroe[153] wrote that lumbar puncture can be accomplished as easily with the patient lying comfortably stretched out on his side as it can with his chin and knees approximated

his discomfort extreme and his apprehension increased on that account A hasty glance at any standard anatomy will satisfy the most skeptical that any significant increase in the separation of the lumbar spinous processes by flexion of the cervical spine and thighs is an impossibility The 2 or 3 mm clearance necessary to introduce a lumbar puncture needle between adjoining bony prominences is available even when opisthotonos is present The usual extreme flexion is *effective only as a means of restraint* in uncooperative or un anesthetized patients and never as a means of increasing the ease with which the needle can be inserted

It has been shown that when the torso is flexed in preparation for lumbar puncture and the needle is inserted *in the midline beyond the neural canal it enters the* inter vertebral disc If the body is not flexed the needle will strike the vertebral body or enter the venous sinusoid or one of the connecting veins *Flexion of the spine in* creases the intradisc pressure and because of the stronger anterior elements of the disc this pressure is reflected in the weaker posterior part causing a slight bulging of the disc into the neural canal

In order to get the spine fully flexed an assistant places one arm under the knees and the other round the back of the patient's neck while explaining to him the neces sity for getting the chin so near to the knees as possible The purpose of this flexion is to widen the intervertebral spaces and thereby facilitate the entry of the needle A roller towel placed round the neck and knees and tightened by twisting with a rod sometimes helps to maintain the flexed position (*Extreme flexion widens the space* between the spinous processes but does not alter the distance to any extent between *the laminae*)

The long axis of the spine should be parallel to the floor If the puncture is to be carried out in bed it is best to insert a flat board between the mattress and the springs An alternate step is the placement of the patient at the very edge of the bed

Site of Puncture The patient must remain motionless during the puncture

It can be made at any level but the sites usually selected for injection into the subarachnoid space are either between the spinous process of the third and fourth (Quincke s point on a line connecting the uppermost iliac crests) or between the fourth and fifth lumbar vertebrae (Tuffier s point) slightly to the left of the midline (*which is better than directly on the midline, as some surgeons advise*)

Sterilization of Skin The back is painted with alcohol and iodine which in turn is removed with another coat of *alcohol Sterile towels are placed* (a) underneath the patient (b) over the buttocks (c) over the lower ribs and (d) over the loin A rec *tangular sterilized space is left from* about the beginning of the sacrum to the second lumbar vertebra

The operator sterilizes his hands

The Puncture A space between two spinous processes is selected with the thumb The spinous process below is palpated and the spinous process above The pulp of the thumb is placed on the spinous process above and the skin is stretched in an up ward direction The patient is forewarned that he will feel a prick A little 2 per cent procaine is injected into the skin The needle is then inserted *more deeply and more* local analgesic agent injected

The spinal needle is inserted with the bevel *parallel to the long axis* of the body, thus splitting rather than cutting the dural fibers Withdrawal of the needle is done

slowly until fluid no longer drips from the hub this being an attempt to prevent herniation of the meninges into the wound

(The lumbar puncture needle should be carefully chosen it should have a short bevel and the point should always be kept very sharp)

The needle—16 or 20 gauge—should be angulated cephalad so that in case it is inserted too deeply it will strike the posterior surface of the superior vertebra

The left thumb again finds the space and as before the skin is stretched Moving the thumb upwards it is made to rest on the inferior surface of the upper spinous process

The lumbar puncture needle is grasped firmly in the right hand by the hilt and its point is inserted through the skin of the interspace guided by the left thumb nail Both hands should work simultaneously when introducing the spinal puncture needle The point of the needle is controlled so that if there is a sudden 'give the needle will not be rapidly advanced and so travel too far across the subarachnoid space

The needle is advanced a short way perpendicular to the skin surface The left thumb is then removed and the needle circumspectly advanced by steady pressure with both hands the left hand holding the shaft of the needle to prevent it going too far

As the ligamentum flavum is reached there is a characteristic sense of density and interference with the point of the needle When penetration is effected it is followed by a sharp click as the point of the needle passes through the tense dura mater The stylet is withdrawn at frequent intervals

If spinal fluid fails to flow or having started stops flowing the needle is rotated on its long axis (Nerve roots may float up against the bevel)

Under ordinary circumstances 10 cc of clear spinal fluid is withdrawn

The patient is then placed flat on his back in which position he remains for the next 24 hours The head should be kept low but the patient may turn from side to side

Difficulties of Lumbar Puncture If cerebrospinal fluid fails to appear the needle, without the stylet is cautiously advanced a few millimeters If this fails the needle is rotated and slightly withdrawn When there is still no flow the stylet is replaced and then withdrawn If the cerebrospinal fluid fails to appear on removing the stylet for the second time the needle is again rotated

If the patient complains of pain down the leg the needle has struck one of the roots of the cauda equina The point of the needle must be withdrawn almost to the skin and re inserted with a slight upward tilt

Bone is struck from an impinging point of the needle when spinal flexion is inadequate The needle is withdrawn Another attempt is made to increase spinal flexion and the needle is re inserted with an upward tilt (Sometimes when there is osteo arthritis of the spine proper flexion is prevented) If the attempt is unsuccessful another interspace is selected for puncture

The presence or absence of a hydrostatic block of the spinal canal above the site of lumbar puncture is discovered by making pressure upon the jugular vein on each side (Queckenstedt test) with the result that the egress of blood from the cranium is barred and the intracranial pressure is increased This in turn will increase the pressure in the spinal canal which is registered by the manometer unless a complete block has occurred above the lumbar puncture needle

"Dry Tap" When there is a "dry tap" care should be taken that the needle is in the subarachnoid space If there is pain it is probable that the needle has not been introduced in the midline

Sometimes there is a "dry tap" because the needle has been pushed in too far through the subarachnoid space and into the back of the vertebra or intervertebral disc At times merely a drop or two of spinal fluid flows This is usually occasioned by a nerve root floating up against the bevel of the needle The needle should then be turned on its long axis

The stylet in the needle sometimes does not fit properly and does not extend to the very end of the bevel or the needle when introduced, may be plugged by skin

"Bloody Tap" The usual procedure is to collect 2 or 3 cc in each three consecutively used test tubes In almost all "bloody taps" caused by trauma the fluid gradually clears of blood so that clear, or almost completely clear, fluid is obtained in the third test tube When blood is intimately mixed with spinal fluid and has been for some time the three test tubes contain equal amounts of blood

Needle Breakage There are usually two kinds of accidents and the treatment varies somewhat *In the first variety the break occurs during insertion and is realized when the stylet jams*, in this case the stylet and needle are left in position as a guide to the broken fragments and an immediate attempt is made to remove them

In the second variety of accident the needle breaks on accouut of some sudden movement on the part of the patient after the stylet has been removed It is usually best to localize the pieces by roentgenograms and an attempt at removal is made at some later date

Sequelae *Some of the sequelae of lumbar puncture are*

(a) Headache
(b) Vertigo with or without visual disturbances
(c) Nausea and vomiting
(d) Pain at the site of puncture sometimes radiating to the hips

Headache is the commonest sequel It is presumed to be caused by leakage of spinal fluid through the dura into the extra dural tissues

The headache is occipital or occasionally frontal Associated symptoms may be nausea or stiffness of the neck

In patients with post puncture headache the spinal fluid pressure is abnormally low

One of the characteristic features of spinal puncture headache is that the sufferer has it only when the head is raised and not when the head is lowered It is best to keep the patient flat for twenty four hours after the puncture, without a pillow He is allowed to turn from side to side but he is not allowed to raise his head The head of the bed is gradually elevated after a few hours until the pain disappears A grain of codeine or aspirin every four hours often gives relief

The use of a double needle as a rule prevents post puncture headache *One variety* consists of two needles one inside the other and a stylet A screw fixes the position of the inner needle The outer needle reaches the ligamentum flavum and the inner needle punctures the dura (The needle should be turned so that its cutting end separates rather than transects the fibers of the ligament) The sitting position is best and a syringe must be used to withdraw the cerebrospinal fluid

Complications Serious complications are uncommon

If the needle is allowed to deviate from the midline in the deeper part of its course it is probable that one of the lumbar nerves will be struck and thereby cause acute pain in the lower limb on that side

Respiratory Depression When the injectant extends to motor divisions of thoracic nerves the thorax will not expand with inspiration and only diaphragmatic breathing goes on If the injectant passes to the level of the fourth cervical nerve root the diaphragm becomes paralyzed and complete respiratory paralysis takes place

Hypotension Extreme fall in blood pressure is commoner with high spinal analgesia than when the surgical site is in the lower abdomen

It is dangerous to allow hypotension to supervene This fall of blood pressure is owing chiefly to peripheral arteriolar and capillary dilatation in the areas from which sympathetic control has been temporarily removed with consequent stagnation in those areas reduced venous return and impaired cardiac output The hypotension appears shortly after the onset of analgesia usually within five minutes and is aggravated by alterations in the patient s position

Once the blood pressure has been stabilized by the use of vasopressor agents or if extreme care is taken to prevent sudden and major changes in position there is no fall of blood pressure

It is well to remember that the patient under spinal analgesia and any patient in whom the peripheral vascular bed may not be under complete control should not be subjected to rough handling

A few other factors contribute to the fall in blood pressure associated with spinal analgesia Intercostal paralysis from high levels of analgesia with high concentration of the drug causes decreased pulmonary ventilation with attendant hypoxia, carbon dioxide retention and decreased cardiac output Excess carbon dioxide in the presence of sympathetic paralysis of the peripheral vessels causes further dilation of those vessels On this basis the use of carbon dioxide inhalations for resuscitative purposes is definitely contraindicated in a patient with spinal analgesia The fall in blood pressure may also be enhanced by paralysis of the carotid sinus mechanism which prevents reflex compensation

The hypotension associated with spinal analgesia results in imperfect oxygenation of the higher centers and the cerebrum This hypoxia initiates another train of symptoms frequently *noted in patients under spinal analgesia* These are nausea and vomiting mental confusion and anxiety air hunger and tachycardia

Epinephrine is not satisfactory because it causes a serious secondary fall in pressure The drug need not be used routinely and need be given only to those patients in whom it is anticipated that the level of analgesia would be such as to cause significant sympathetic paralysis *For practical purposes this means that* any level of analgesia above the tenth thoracic segment may be sufficient to precipitate hypotension It is more important to administer these drugs prophylactically to a patient with hypertension than to the patient with normally low blood pressure The patient with hypertension is less capable of compensating and is more susceptible to thrombosis following *a period of low tension It is important to give the vasopressor drug* intramuscularly fifteen minutes prior to the onset of analgesia in order to allow time for absorption of the drug into the blood stream

Gastric Upsets Nausea, retching and vomiting are common complications of single dose spinal analgesia The apprehensive patient can be quieted by the intravenous use of morphine or 1 to 3 Gm of pentobarbital sodium

Headache Treatment is prophylactic and combative For the former the use of a small needle, surgical and chemical cleanliness blocking foot of bed for 12 to 24 hours *Strong light and reading should not be permitted*

Treatment of the established headache depends on the cerebrospinal fluid pressure, if this is thought to be low the following measures may help intrathecal injection of 100 to 200 cc of distilled water If cerebrospinal fluid pressure is thought to be high lumbar puncture, intravenous glucose 50 per cent in normal saline 50 to 200 cc, magnesium sulphate, 50 per cent solution 2 cc, intravenously

Magnesium sulphate 50 per cent enema, 6 ounces, may be given Caffein sodium benzoate, 7½ grains intravenously, repeated, is also useful Constant head-down position is effective

Injury to the Intervertebral Disc This injury apparently causes a severe arthritis which sometimes develops after lumbar puncture The patient, at first feels no pain but some weeks or even months afterwards, intense lumbar backache develops

Examination shows the lumbar spine held rigid by muscle spasm in the flexed position and a roentgenographic examination reveals arthritis localized to one intervertebral joint with loss of joint space

The condition is largely progressive Treatment during the active state is by fixation in a plaster extension jacket

Prolapse of Intervertebral Disc This accident, occasioned by lumbar puncture, has sometimes been reported in the surgical literature

Cerebral Hemorrhage This is a rare complication caused by a too rapid withdrawal of cerebrospinal fluid, especially where intracranial pressure is raised

Osteomyelitis of the Spine This complication was reported by Leonard Findlay and F H Kemp [154]

Hemorrhages in the Spinal Cord and Hindbrain This complication has been reported occasionally

Special Circumstances The methods which are useful in special circumstances in high abdominal surgery are

(a) Endotracheal nitrous oxide oxygen ether, with subsequent hyperventilation with carbon dioxide oxygen

(b) High spinal block

(c) Field block of the abdominal wall combined with splanchnic block The best field blocking for extensive explorations is the costo iliac one Wheals are raised along the costal margin starting at the ensiform cartilage and downward to the tip of the eleventh rib and from there, again downward to the anterior superior iliac spine The injectant is placed subcutaneously (joining the various wheals) and fanwise in the muscle layer

A separate splanchnic block can be obtained in two ways First the abdomen is opened, the hand is introduced and the aorta gently retracted with the finger Novocaine (50 cc ½ per cent) solution is then deposited in close contact with the lateral aspects of the body of the first lumbar vertebra (Braun s anterior technic) In the second method (Kappis s) the posterior approach is used Before the abdominal wall

blocking is accomplished the patient is placed on his side and a point is selected 7 cm external to the spinous process of the first lumbar vertebra This point should be directly below the twelfth rib Through it a 12 cm needle is introduced at an angle of 45 degrees to the median plane The point should be felt striking against the side of the vertebral body The needle is then partly withdrawn and reintroduced in a slightly more forward direction until its point is felt to slide at a tangent past the bone It is then pushed 1 cm farther in The aspiration test being negative 20 to 30 cc of 1 per cent novocaine solution are injected The patient is then turned over and the same process is repeated contralaterally

A modified technic of anterior splanchnic analgesia is accomplished according to Arnold (of Lincoln Nebraska) in the following manner

The abdominal wall is anesthetized with 1 per cent novocaine solution containing 3 minims of adrenalin solution to each ounce of the anesthetic agent The area injected is from the ensiform cartilage to the umbilicus

The midline incision is carried through the abdominal wall into the peritoneal cavity The peritoneum is anesthetized in an area of one and one half to two inches from the cut margin circumscribing the incision

The left hand (if the surgeon is right handed) is inserted and the stomach is gently drawn downward until the gastrohepatic ligament or lesser omentum is seen An injection is made into the structure

The forefinger of the left hand exerts gentle pressure downward on the gastro hepatic ligament until the abdominal aorta is palpated The vessel is gently retracted to the left, the pancreas is drawn downward and the finger feels the anterior body of the first or second lumbar vertebra and remains between the abdominal aorta and the vena cava in the area of the celiac axis in the middle of the plexus of the same name

A large Finsterer splanchnic needle (seven inches long) is inserted to meet the anterior body of the vertebra upon which the forefinger rests Seventy five to 100 cc of ½ per cent solution of novocaine are injected with the customary amount of adrenalin into the retroperitoneal space

(d) Combined paravertebral and splanchnic blocks A bilateral paravertebral from D 7 to D 12 can be substituted for the anterior field block The patient is placed on his side and a number of wheals are raised 4 cm from the midline opposite the selected spinous process Through these wheals an 8 cm needle is passed perpendicularly to the skin surface until its point is felt to impinge upon the rib It is then slightly withdrawn and re introduced downward and inward toward the lower border of the rib The needle is finally carried 2 cm past this point and if the aspiration test is negative 5 to 6 cc of 1 per cent novocaine solution are injected When all the injections are completed the splanchnic block is carried out

Continuous Spinal Analgesia (Serial Analgesia Fractional Analgesia) For prolonged abdominal operations continuous spinal analgesia introduced by W T Lemmon in 1940 is highly effective His theory was that after the nerve roots have soaked up their full of analgesic drug much of the injected solution remains in the cerebrospinal fluid inactive from which it can be absorbed into the blood stream with the production of toxic symptoms Thus he devised a technic for making serial injections of minimal amounts of drug

Surgeons and anesthetists are well aware of the occasional great inadequacy of

single dose spinal analgesia, namely its uncertain duration (about one hour) which requires combining this technic with the use of other agents and technics Continuous spinal analgesia should therefore be used for patients whose physical condition permits the use of the method when long surgical intervention is contemplated

The method is useful when either the scope or the duration of the operation is uncertain It enables minimal dosage to be given without fear of inadequate analgesia and so is desirable in the aged the very young, and the physically handicapped

The advantage is obvious in that the anesthetic agent can be added intermittently as required without risk of administration of large initial doses

Other advantages in this technic are

(a) No limitation of length of action

(b) Smaller doses of the drug in the intrathecal space at any one time

(c) Low effective concentrations of the drug, 2–5 per centum

(d) Termination of the analgesia at will by the removal of spinal fluid

The chief disadvantages are needle breakage and displacement of the needle point from the subarachnoid space during the positioning of the patient These risks can be minimized or obviated by using a large (15 gauge) lumbar puncture needle and passing through it a No 4 ureteric catheter so that its tip lies 4 to 5 cm beyond the needle point The needle is then removed leaving the catheter in position The principle is similar to that of the serial caudal block technic

Glucose in concentrations of 5 or 10 per cent may be added to procaine spinal fluid solution One or the other concentration of glucose is usually added in equal parts with the procaine spinal fluid solution and the total amount of the mixture should equal that used when procaine and spinal fluid are used alone (Glucose hastens the onset of analgesia)

Cyclopropane may be used during the last hour or so of the surgery During much of the manipulation both lungs can be kept normally inflated but when dissection in the mediastinum requires lung retraction small areas of absorption collapse are almost sure to occur These are not harmful unless left too long in that state The anesthetist should inflate the lungs at least every twenty minutes

The apparatus necessary for continuous spinal analgesia consists of

(a) A special mattress

(b) A Sise introducer

(c) Special needles

(d) A Luer Lok syringe

(e) A three foot length fine bore thick walled rubber tubing

The mattress measures five inches by eighteen inches by six feet and contains a seven inch gap on one side beneath the lumbar spine

The Sise introducer is a short large needle of sufficient diameter to admit a spinal needle The spinal needles are 17 18 or 19 or 20 gauge, 2½ 3 and 3½ inches in length They are malleable

The Luer Lok syringe generally used is of 10 cc or 20 cc capacity

The tubing is fitted with Luer Lok connections one to attach to the hub of the spinal needle and the other (which is provided with a stop cock) to the syringe

The patient before being turned on his side is placed flat on his back so that the site of the purposed tap rests directly over the gap in the spinal mattress This per

mits resumption of the proper supine position with a minimum of shifting He is then carefully rolled onto his side The hips and knees are flexed and the latter are approximated to the chin

After painting the skin with the selected antiseptic and placing a sterile drape a wheal is raised over the spinous interspace used as a landmark

The second lumbar interspace is used for upper abdominal procedures and the third for surgery in the lower abdomen

A quantity of ephedrine is mixed with 1 5 cc of 0 5 per cent procaine which is used to infiltrate the skin and interspinous ligament

The Sise introducer or an ordinary spinal needle of the same calibre can be substituted to penetrate the skin and interspinous ligament The needle is introduced until its point enters the dura and is left in situ protruding in the mattress gap

All air is expelled and the free end of the tubing is connected to the lumbar puncture needle after removal of its stylet After aspiration to test the fluid continuity of the system the initial dose of novocaine is injected The tap is turned off to prevent leak of cerebrospinal fluid back into the tubing and syringe An average of 50 mg of novocaine is required each half hour to maintain analgesia

The anesthetic solution is made by mixing a 10 per cent solution of procaine with a quantity of spinal fluid Three cc of 10 per cent procaine and 9 cc of spinal fluid are mixed to make 12 cc of a 2 5 per cent solution each cc of which contains 25 mg of anesthetic drug A 5 per cent solution is made by mixing 6 cc each of 10 per cent procaine and spinal fluid This preparation contains 50 mg per cubic centimeter and is used for intra abdominal operations

(It is maintained by some anesthetists that the use of a dilute 1 per cent solution of procaine renders continuous spinal block a safe method A greater margin of safety *is assured*)

The syringe containing 12 cc of well mixed anesthetic solution is attached to the rubber tubing which in turn is filled by injecting 2 cc from the syringe The stop cock is then turned off and the other end of the tubing is fixed securely to the hub of the spinal needle

The patient is then rolled onto his back so that the spinal needle and attached tubing as previously stated find protection in the gap in the mattress

A 5 degree Trendelenburg tilt is maintained until the desired level of analgesia is reached the solution being of course hyperbaric After twenty minutes a drip of 0 5 per cent procaine at about eight drops per minute is started This rate may have to be altered to keep the level of analgesia constant and to provide adequate relaxation

(If pontocaine is used the following points must be kept in mind The specific gravity of 1 per cent pontocaine in saline as supplied is 1007 which is about equal to the average of spinal fluid which ranges from 1001 to 1009 By adding 10 per cent glucose to the anesthetic solution the specific gravity *of the mixture is made greater* than the spinal fluid One part pontocaine to $1\frac{1}{2}$ parts 10 per cent glucose gives a specific gravity of 1 013 and by making the injection with the patient in various positions—Trendelenburg level or Fowler—the height to which the solution flows in the spinal canal can be controlled)

The signs of waning analgesia include restlessness flushing of the face warm perspi

ration, rise in blood pressure quickening of the pulse, increase in tone of the abdominal muscles and relaxation of the intestines

Paravertebral Thoracic Block This technic was suggested by Sellheim (1909) and subsequently developed by Lawen (1911) who designated it "paravertebral conduction anesthesia" A local analgesic agent is injected contiguous to the vertebral column where the nerve trunks issue from the intervertebral foramina

Wheals are raised 4 to 5 cm from the midline opposite the lower borders of the dorsal spines The recorder is set at 4 to 5 centimeters The needle is directed perpendicularly through each wheal to find the bone which is contiguous to the transverse process This is usually found at a depth of 3 centimeters The needle is then partly withdrawn and directed somewhat medially and cephalad over the upper border of the transverse process, or caudad, to the transverse process until it slides past the tip on its way to the body of the vertebra The point of the 12 cm needle should rest close to the anterolateral surface of the body of the vertebra The aspiration test is made and then 5 to 10 cc of procaine solution are injected

There may be hemorrhage from rupture of dural vessels It is possible also to inject the analgesic agent accidentally into the subarachnoid space if sleeves of dura, pia mater and arachnoid extend out along the somatic nerves and the rami communicantes

An alternative technic in paravertebral thoracic block is accomplished in the following manner wheals are formed about three finger breadths from the midline In each, successively, a needle is thrust at an angle of 35 degrees to the saggital plane until it slides off the lower border of the rib The needle is circumspectly projected until at a depth of 6 to 7 cm it hits the vertebral body Ten cc of injectant are now placed between the rib and the vertebra avoiding the dura

A variant technic of maintaining continuous lumbar paravertebral sympathetic block was described by Thomasen and Moretz[155] A No 3½ indwelling catheter is placed in the area of the second lunbar ganglion Procaine and penicillin are injected every three hours

The equipment is similar to that utilized in continuous spinal analgesia and includes a No 16 Tuohy needle with a Huber directional point and a 3½ Tuohy catheter, a No 23 gauge needle with a blunt edge a plug to fit into the hub of the needle and a sterile test tube

The patient is placed on the contralateral side to the selected site The Tuohy needle is inserted directly beneath the transverse process of the second lumbar vertebra The Huber directional needle point is toward the midline The catheter is then inserted through the lumen of the needle until it reaches the distal end of the needle While the catheter is in position and held with one hand the needle is removed by sliding it off the catheter with the other hand A blunt pointed No 23 needle is inserted into the free end of the catheter and procaine is injected through the catheter at the site of the lumbar sympathetic chain

Thomasen and Moretz use 8 cc of 1 per cent procaine mixed with 30 000 units of penicillin for each injection Between injections the needle is closed with the metal plug With the catheter still attached it is placed in a sterile test tube which in turn, is closed with a sterile cotton stopper An abdominal pad is placed over the catheter This pad and test tube are affixed to the side of the patient with adhesive strips

Splanchnic Anesthesia in Gastric Surgery The advantages are that it gives adequate anesthesia in most instances and that it is the least shocking of all the methods available

Splanchnic anesthesia may be defined as the infiltration with a procaine solution of the retroperitoneal tissue in the vicinity of the solar plexus (abdominal brain—Bichat)

The splanchnic nerves contain the sensory pathways from the upper abdominal organs in laboratory animals The great splanchnic nerves in man arise from four or five roots which spring from the branches which lead to the middle thoracic ganglia These ganglia receive fibers from the fifth or sixth to the ninth or tenth dorsal nerve by way of the rami communicantes The trunk of the great splanchnic nerve is formed from its constituents on the lateral surface of the eleventh dorsal vertebral and enters the abdomen by piercing the crus of the diaphragm to join the semilunar ganglion on the same side

The small splanchnic nerve arises from the lower thoracic ganglion of the sympathetic cord which is connected with the tenth eleventh and twelfth dorsal nerves This trunk passes with or lateral to the great splanchnic nerve into the abdomen to joint the semilunar ganglion The two semilunar ganglia are situated one on each side of the midline at the level of the first lumbar vertebra

The semilunar ganglia together with the coeliac aortico renal and superior mesenteric ganglia form the solar plexus This plexus gives rise to the gastric phrenic, hepatic splenic suprarenal renal spermatic or ovarian aortic mesenteric hypogastric and pelvic plexuses From these plexuses the nerve fibers are distributed along the arteries and their branches to their respective organs

It is necessary to anesthetize the anterior abdominal wall and the parietal peritoneum in addition to the solar plexus

There are a number of technics The anterior and posterior routes have been previously described

Supplementary Anesthesia The various supplementary procedures are as follows

(a) Contemplated from the start and may be given either before or after the spinal injection

(b) Administered during the course of surgery owing to incomplete anesthesia or extension of scope of operation because of emotions discomfort and anxiety on the part of the patient or persistent vomiting or restlessness

(c) Intravenous inhalation or a combination of the two may be used Light ether or light cyclopropane can be given before a spinal injection By the use of these methods the patient is not aware that he has undergone a spinal analgesia

Alternatively the spinal analgesia is given in the usual manner When it is ascertained that it is effective a light general anesthesia is given (For surgery below the umbilicus pentothal makes an excellent supplement but for higher blocks an inhalation agent is preferred by many surgeons)

Intravenous morphine one-eighth to one-quarter of a grain may be sufficient to quiet a nervous patient

Intercostal Nerve Block in Upper Abdominal Surgery Efficacy of Efocaine The relatively high incidence of pulmonary complications following upper abdominal surgery has been attributed to hypoventilation caused by limited respiratory ex

cursions owing to postoperative pain Kahn showed that stimulation of the central end of any intercostal nerve causes reflex inhibition of respiration This was also shown to be true in stimulation of the peripheral branches including those to the rectus abdominis muscle A significant decrease of pulmonary ventilation following upper abdominal surgery has been repeatedly reported by many investigators The respiratory inhibition amounts to approximately 60 per cent depression of the mean vital capacity during the first few postsurgical days Churchill and McNeil[154] found that 25 per cent of presurgical vital capacity was present twenty four hours after operation and Powers reported this value as 33 per cent in his series

Atelectasis has been recognized as the predominant early postsurgical pulmonary complication and a primary condition in the development of pneumonia The loss of the cough reflex following upper abdominal surgery is a significant predisposing factor Secretions which are normally removed by cough and ciliary action remain in the lungs and sometimes induce lobar or lobular obstruction Unless vigorous measures are taken the micro organisms of the upper respiratory tract invade the collapsed area with consequent serious complications

The pulmonary complications that endanger life and contribute to morbidity are atelectasis and pneumonia The lobular atelectasis that is frequently discovered is either ameliorated or goes on to bronchopneumonia Any procedure which prevents or limits the predisposition to these complications is obviously of more than theoretic significance Cutler and Hoerr reported an incidence of pulmonary complications of 11 per cent in biliary tract procedures and 23 per cent in gastric surgery Mimpriss reported that 29 per cent of patients in a series of 100 gastrectomies showed varying degrees of lobular and lobar atelectasis while Blodgett and Beattie cited 11 per cent pulmonary complications in first day ambulatory patients and 13 per cent in non early ambulant patients following upper abdominal surgery It is of importance to note that the highest incidence of these complications followed gastric surgery rather than other upper abdominal procedures It is recognized that other factors enter into the causation such as advanced age and its consequent physical deterioration

The primary atelectasis is attributable to the greatly reduced respiratory excursion resulting from a combination of the following factors intimately associated with post surgical pain in the surgical area splinting of the diaphragm tight abdominal dressings and binders an inhibition of deep breathing and coughing and respiratory depression resulting from morphine and the opiates The tendency of the patient to remain in one position is also a factor of concern particularly in the development of venous thrombi Tight abdominal binders and narcotics tend to depress pain sensations arising from contraction of the abdominal muscles and depression of cough reflex Similarly because the abdominal muscles are active in respiration the patient is reluctant to take deep breaths because of the associated pain The high incidence of postsurgical pulmonary complications is therefore not surprising

While many methods have been advocated to reduce stimulation of the intercostal nerves and resultant hypoventilation they are for the most part found inadequate The approach has been two fold the first was directed at placing the incision in an advantageous area and direction so as to interfere with so few sensory nerves as possible Transverse incision has been suggested as a step toward achieving this purpose

The objective of the second approach was the control of postsurgical pain by the use of local infiltration with an analgesic solution Bickham[157] advocated injection of the abdominal wall with quinine and urea hydrochloride Cappelle[158] suggested the use of continuous infiltration of the wound area with procaine solution These technics have in the main been replaced by other procedures Gius Starr and Gilman [159] Zollinger Belinkoff and Graham [160] Seldon and Priestley described technics of inter costal nerve block with local analgesic agents

While this approach appeared to hold great promise the injectant solutions had many inadequacies The short acting aqueous preparations did not produce analgesia of sufficient degree or duration requiring repeated frequent blocks which met with patient resistance While there was apparently better success with the injectant oil solutions the disadvantages of the oil solvent were obvious and well known

The pharmacologic and clinical action of Efocaine (E Fougera & Co Inc) indi cates that it is of special interest as an agent to be used for intercostal nerve blocks It is an aqueous solution which produces a local anesthesia of approximately two weeks duration without local tissue reaction

The value of the intercostal block in patients undergoing upper abdominal surgery is twofold the greatly decreased incidence of pulmonary complications and the reduc tion of morbidity owing to effective pain control

When effective intercostal nerve block has been accomplished there is a definite increase in vital capacity in the first few postsurgical days A vital capacity of about 23 per cent greater than with other technics has been recorded by different investi gators Moreover the blocked series achieved a basic level of vital capacity ap proximately two days before a control series Thus the mean vital capacity of the experimental series on the first postsurgical day was the same as that achieved by the control group on the third postsurgical day This serves to illustrate what can be accomplished through intercostal block technics

Technic The intercostal nerves pass through the intervertebral foramina and run in a groove behind the lower edge of the rib between the internal and external inter costal muscles They pass below the costal cartilage at the costal arch into the ab dominal wall The nerves pass toward the midline in an oblique and downward direc tion innervating the skin and muscles of the anterior abdominal wall with the exception of the inguinal regions Bartlett has shown that the intercostal nerves are most accessible in the area from the mid scapular to the anterior axillary lines where they course in a closed compartment beneath and behind the rib

The technic described by Bartlett is commonly used The patient is placed recum bent The thoracic cage is elevated by means of a small pillow to make the field easily accessible The arm is raised above the head in order to stretch the skin taut over the ribs After proper preparation of the surgical site the intercostal block is accomplished by inserting a 22 gauge 1½ inch needle so as to impinge on the rib The needle, in serted perpendicularly slides over and under the rib where the intercostal nerve lies Aspiration is carried out prior to injection in order to ascertain that the needle has not punctured a blood vessel nor is in the pleural cavity The solution is injected and the needle is withdrawn It is desirable then to massage the area in order to distribute the anesthetic solution

The process is repeated over the next rib until the desired area is anesthetized Bilateral blocks may be carried out for midline incisions or *where an extensive transverse incision is to be made* Some thought should be given to the selection of nerves *to be blocked* *These are* as a *rule, the sixth to the eleventh* intercostal although it may be varied to suit personal *requirements*

The amount of Efocaine injected is from 1 to 2 cubic centimeters *The mean anesthetic* duration is generally *more than 10 days* when either quantity *is used There* appears to be no advantage in injecting more or less of the solution Since Efocaine *is miscible with the body fluids it is not encapsulated* and the solvent phase takes place rapidly even in the event of inefficient injections

While the technic of administration is relatively simple a few points must be stressed Some surgeons prefer the posterior paravertebral approach because lateral cutaneous branches of the intercostal nerve diverge in the area of the mid axillary *line There is always the possibility when injecting in the mid axillary area that owing* to the small quantity of solution placed one branch may escape contact with the drug The space described by Bartlett does not extend posteriorly The nerves lie beneath the intercostal muscle and are much closer to the pleura than in the mid axillary line The objection to the posterior approach is the possibility that a paralysis of the intercostal muscles *may result because the motor nerves innervating these muscles take* origin posteriorly The additional danger of an intrapleural injection is also present Both of these complications are minimized when the mid axillary approach is used The possibility of an incomplete block is negligible in relation to the safety factor

Efocaine is a rather unique analgesic agent It is safe and effective producing analgesia *for prolonged periods of time* The anesthetized area is a cause of little concern and presents no problem to either physician or patient There is no interference with wound healing or local tissue reactions The desensitized area gradually diminishes in size and normal sensitivity always returns

The use of Efocaine in conducting the intercostal nerve block eliminates many of the factors predisposing to pulmonary complications in upper abdominal procedures It is without apparent drawbacks Clinically and especially from the viewpoint of the patient the technic is worthy of widespread use

Intravenous Anesthesia

Pentothal sodium is not irritant to the respiratory tract and produces only slight changes in body chemistry Respiration is quiet under its administration It is however *seldom adequate for gastric surgery* when used alone, as the large dosage required to produce relaxation causes too great respiratory and postsurgical depression Combined with nitrous oxide and oxygen (20 to 50 per cent) pentothal sodium may prove satisfactory for quick operations in debilitated or asthenic patients

Anesthesia in Inoperable Gastric Cancer

The use of intrathecal absolute alcohol has been advocated for the relief of pain in *inoperable cancer and is said to be* safer than other means The injection is a hypobaric one The patient rests with his head low, his affected side uppermost and the spine flexed laterally by sandbags so that the nerve roots aimed at lie at the highest

level The body is also tilted forwards so that the posterior roots will be affected rather than the anterior ones

The alcohol is injected at the site of the desired block at the rate of 0 4 cm per minute up to 1 cubic centimeter After twenty minutes the patient is turned on his back Relief may be immediate and in any case should occur within two weeks and last about six months

Where a palliative procedure for the very feeble is contemplated (jejunostomy for example) a field block is used

CHAPTER X

Surgery

Chronology

1810 Merrem, Paul Carl Theodore, refers to American surgeon, John Jones who accomplished first pylorectomy experimenting on dogs Merrem gave following criteria for accomplishing operation (1) if patient seems the sure prey of death after having been sick for long time and after every other remedy has been tried to no avail, (2) if we find on placing fingers on right region of stomach an unmistakable hardening, (3) if a short time after eating patient suffers from obstruction of bowels and chronic vomiting

1837 Egelberg Norwegian military surgeon, advised operation for esophageal stricture He did not perform the operation

1842 Bassow carried out gastrectomies on dogs

1843 Blondlot carried out gastrectomies on dogs

1849 Sedillot, C E, first carried out gastrectomy on human beings

1865 Torelli Ruggero, first to be credited for resection of part of stomach of a human being It was a resection of anterior stomach wall which was incarcerated *in fissure of ventral hernia Patient recovered*

1866 Von Hacker suggested his technic—a two stage operation Anterior wall of stomach sutured to abdominal wall leaving it for four or five days until *secure adhesions were formed between exposed surfaces Then stomach opened,* but gastric contents still escaped through new stoma into peritoneal cavity

1871 Billroth C A Theodor, experimented in esophageal resection on dogs At first accomplished a gastro enterostomy according to Wolfler s method and then added to it the extirpation of the cancer At this stage the duodenum first was cut and separated its lumen turned in and then closed with two layers of Lembert sutures The stomach was finally cut off at a distance of one half centimeter from the anastomosis and the opening was closed immediately by occlusion sutures and on top of this by Lembert sutures

The Billroth II operation was reported by von Hacker at the Fourteenth Congress of the Deutschen Gesellschaft fur Chirurgie at *Berlin (April 10* 1885) and published the same year His report in part is as follows

> After the abdominal cavity had been opened it was possible to draw forward the tumor which was the size of a fist *freely movable and not adherent* It was seen that the new growth extended far up especially on the greater curvature Since the patient was in very poor condition Prof Billroth first performed a gastro enterostomy in order to be able to end the operation in case threatening symptoms should appear The gastrojejunostomy was *performed according to Wolfler s method* the jejunum was drawn up over the transverse colon and *fixed to the stomach* in front of the transverse colon Since the patient was not in a state of collapse at the

end of the rapidly completed operation and the pulse was strong the extirpation of the cancer was immediately undertaken The tumor was isolated in the usual manner at the lesser and greater curvatures the tumor was first divided from the duodenum while the latter was compressed by the hand of an assistant hereupon the end of the duodenum was inverted into its lumen and the duodenum closed with Lembert sutures in two rows When the stomach lumen was opened it was immediately cleansed with a special sponge and another one was placed in the interior of the portion to be resected Then followed the division on the side of the healthy stomach and the immediate placing of occlusion sutures over which in the interspaces separate Lembert sutures were placed In the stomach the occlusion was likewise executed by manual compression After resection had been effected it was seen that on account of the cancer the incision would have to be carried downward on the greater curvature as far as one half centimeter from the gastrointestinal fistula which had been made and even here the wound surfaces appeared infiltrated Both operations including the closure of the abdominal walls had lasted one and three-quarter hours The course was entirely favorable and without reaction

Even though we did not succeed in effecting a radical cure here yet the case demonstrates the feasibility of the method In the future in similar cases in case one should wish to carry out a preliminary gastroenterostomy as a precaution one should make the fistula still nearer the fundus Technically to be sure it is easier to undertake the resection first Once could then presently use the lower part of the stomach wound for application of the jejunum especially in case of extensive cancer on the greater curvature when the incision follows an arched form

(The method devised by Billroth in 1885 the so-called II had several advantages no danger of tension a large gastrectomy could be performed whereas the fatal suture angle could be totally avoided)

1875 Jones Sydney first successful gastrectomy

1876 Verneuil A A modification of Sedillot s technic

1876 Gussenbauer and von Winiwarter reported their observations on dogs in which subtotal resection of the stomach had been accomplished Their publication marked an epoch because it demonstrated dogs could live indefinitely after resection of considerable parts of stomach

1877 Czerny Vincenz first excised part of cervical esophagus for cancer in man leaving patient with a fistula

1879 Pean Jules on April 9 accomplished first pylorectomy on man elsewhere in the world and especially in Europe the operation is known as Billroth I method of gastrectomy because Billroth s was the first successful use of resection and direct anastomosis [161]

1881 Billroth I operation [16]

1881 Wolfler anterior gastroenterostomy suggested by Nicoladoni

1882 Jaboulay gastroduodenostomy

1883 Czerny Vincenz successful elliptic excision and transverse reunion of a stenosed pylorus

1884 Rydygier Ludwig von cured a patient suffering from fibrous stenosis using Wolfler s method It was found that Wolfler s operation of anterior gastroenterostomy was unsuccessful in a number of patients owing to compression of transverse colon by anastomosed jejunal loop Von Hacker attempted to avoid inadequacies of Wolfler s operation by attempting gastrojejunal anastomosis through button hole incision of transverse mesocolon

1884 Conner, Phineas, of Cincinnati, accomplished first complete gastrectomy on a human being [163]

1885 von Hacker, posterior gastroenterostomy first suggested by Courvoisier (1882)

1886 Heineke, *pyloroplasty*

1887 Mikulicz, Johann, pyloroplasty

1888 Von Eiselberg *first used modification of subtotal gastrectomy* known today as the Hofmeister or Finsterer variety of Billroth II

1892 Braun, jejunostomy in conjunction with anterior gastroenterostomy

1893 Doyen, L, pyloric exclusion in conjunction with gastroenterostomy

1894 Bircher, extra thoracic esophagoplasty It consisted of transection of esophagus in neck, divided ends being sutured to skin, upper end being brought down over sternum

1895 Biondie, transpleural route first used experimentally in *esophageal surgery*

1895 Eiselberg pyloric exclusion in conjunction with gastroenterostomy

1896 Fontan (of Toulouse)

> The aim of my operation is to establish a gastric stoma so constructed that the escape of gastric juice will be impossible I have adapted this idea of a valvular operation base on Peniere s experiments In my operation not only the mucosa but all the coats of the stomach enter into the formation of the valve I build the valves *in one sitting, by the aid of a simple operative procedure There has never been* detected any leakage of gastric juice or of gastric contents following this operation and there has never been present any excoriations There has never been present any ulceration "

1897 Schlatter total gastrectomy [164]

1898 Biondie feasibility of transthoracic exposure and resection of lower esophagus and cardia with restoration of continuity by esophagogastrostomy

1898 Brigham total gastrectomy with esophago duodenostomy—*first such operation* performed on man

1901 Depage, tubular gastrostomy, using a flap of stomach

1904 Mickulicz Johann, transthoracic resection of gastric cardia

1904 Enderlen, made first successful exploration of esophagus by mediastinal route and in same year successful transpleural resection of that organ in dog was carried out by Sauerbruch

1908 Voelcker, F, first successful *resection of carcinoma*

1909 Meltzer Samuel James and Auer, John, tracheal insufflation technic

1910 Plummer Henry Stanley, demonstrated that almost all structures of the esophagus can be dilated by making patient swallow fine thread and by using this thread as guide for dilators

1911 Polya Eugene, modification subtotal gastrectomy *(end to side gastrojejunotomy)*

1913 Thorek Max *first successful resection of* thoracic esophagus

1913 Janeway Theodor Caldwell (U S A) tubular gastrostomy

1913 Sauerbruch Ernest Ferdinand, extirpated cancer of upper thoracic esophagus making his approach in neck

1913 Zaaiger axillary esophagostomy

1914 Schwers transpleural and transdiaphragmatic resection in two stages with rib resection
1916 Braun transpleural gastric cardiectomy
1918 Bircher transpleural gastric cardiectomy
1923 Horhammer trans abdominal cardiectomy
1933 Ohsawa direct end to side anastomosis of esophagus to fundus of stomach
1938 Adams and Phemister transthoracic transphrenic excision and direct anastomosis of esophagus to stomach
1942 Meyer Willy first report of successful total gastrectomy using transthoracic approach
1944 Trotter resection cervical esophagus
1947 In recent years operation of choice has been esophagojejunostomy A loop of jejunum is placed either anterior or posterior to the colon

Signs of Inoperability in Gastric Cancer

1 Enlarged hard supraclavicular glands (left Virchow s)
2 Metastatic nodules in liver
3 Indications of secondary growth in distant organs for example the lungs and long bones spine et cetera
4 Metastatic deposits in rectum
5 Palpated multiple masses in abdomen
6 Palpable cancerous omentum
7 Subcutaneous metastatic nodules scattered in abdominal wall
8 Nodules at umbilicus (Dysphagia with mass in epigastrium indicates large growth but not necessarily inoperable by transthoracic route if glands not too extensively involved)
9 Roentgenographic evidence of involvement of an extensive area of the stomach by growth and wide fixation of the organ to neighboring structures
10 Ascites
11 Extensive involvement of glands
12 Presence of a serious associated disease

Pack[165] considers the following varieties of gastric carcinoma as non resectable

Those tumors which at exploration of the thorax are accompanied by hemorrhage freely collected in the pleural cavity neoplastic nodules disseminated in the pleura (histopathologic study by frozen section) adhesions en bloc with the diaphragm determining an immovable tumor and very extensive infiltration extensive invasion of neighboring organs as the aorta the bronchus spinal column et cetera those which after incision of the diaphragm are shown to be accompanied by liver metastases implants in the adjacent peritoneum or the pouch of Douglas (not revealed by clinical examination) extensive infiltration of the adjacent epiploon and the pancreas et cetera

Total Gastrectomy

Care of Patients During Gastrectomy

1 Avoidance of airway obstruction adequate oxygenation
2 Adequate blood and fluid replacement
3 Reduction of reflex disturbances in the surgical area by avoidance of trauma

4 Avoidance of contamination of surgical area
5 Maintenance of adequate blood supply
6 Avoidance of tension at site of *anastomosis*
7 Periodic inflation of lung during intrapleural part of operation
8 Complete re expansion of lung while pleural cavity is closed

Some salient points to bear in mind regarding gastrectomy—total or subtotal—are the following

Systematic exploration must reveal freedom from involvement in the following areas
(a) Foramen of Winslow, the hepatoduodenal ligament
(b) *Gastrohepatic ligament is ruptured to ascertain the extent of lymphatic* involvement around coeliac axis
(c) Spleen visualized to discover possible extension of growth into gastro splenic ligament and to conclude whether splenectomy is urgently re quired
(d) Distal end of esophagus palpated to ascertain mobility and extension of disease past cardia to gauge extent of esophagus available for anastomosis
(e) Posterior wall of stomach examined to discover metastases into peri pancreatic capsule
(f) Superior surface of transverse mesocolon examined to determine condition of middle colic vessels
(g) Cul de sac palpated

Technics in Total Gastrectomy

1 There are two main technics *in total gastrectomy namely*
(a) Removal of stomach (as the phrase denotes) in its entirety and union of the esophageal end with a jejunal loop—esophagojejunostomy
(b) Distal end of esophagus united to end or side of duodenum—esophago duodenostomy
2 During the operation the following structures receive attention
(a) The greater omentum
(b) Lymphatics and nodes along greater curvature
(c) *Nodes of left gastropancreatic fold*
(d) Cardiac nodes
(e) Right gastroepiploic nodes
(f) Infrapyloric and retropyloric nodes
(g) Lymph nodes of lesser curvature
(h) Gastrohepatic omentum
(i) Nodes along coeliac axis
(j) Nodes in gastrosplenic ligament
(k) Spleen
(l) Peritoneum of entire lesser sac
3 During exploration an evaluation is made of the extent of cancerous involve ment and early *appraisal of the* status of distal end of esophagus
4 Sectioning both vagi (according to some surgeons) somewhat high, aids greatly in mobilizing distal esophagus

5 Where the tension between the two anastomotic ends seem too great esophago jejunostomy should be effected This may be done in an antecolic or retrocolic manner and supplemented by entero anastomosis
6 The stomach should be removed *before* the anastomosis is carried out
7 After the suture is complete the omentum is affixed to the suture line by two or three interrupted catgut sutures
8 An important technical step is separation of the omentum from the transverse colon This reveals the lesser peritoneal cavity and exposes the splenic vein and artery They can then be easily ligated at the tail of the pancreas facilitating removal of the spleen and stomach
9 The omentum should be entirely freed from the transverse colon well over on the right side and separated to and including its attachments at the splenic flexure

Indications for Total Gastrectomy

1 The patient should not be a poor surgical risk
2 Site and extent of the cancer found at laparotomy if the lesion has extended to the cardiac lymph nodes from the pylorus total gastrectomy is the only feasible technic
3 The stomach in its entirety and the lower end of the esophagus sufficiently mobile for the contemplated operation to be accomplished by esophageal jejunal or esophago-duodenal anastomosis without great effort or tension on the suture line
4 Non involvement of the esophagus (according to some surgeons)
5 Non involvement of the liver
6 Localized leather bottle stomach
7 Generalized leather bottle stomach
8 Localized malignant growths at fundus
9 Cancer of upper third of lesser curvature
10 Lymphosarcoma with tendency to infiltrate stomach wall

Choice of Incisions for Total Gastrectomy There is a choice of the following incisions

(a) Midline Incision This incision which is the most commonly used in gastric surgery is begun at the tip of the xiphisternum and passes vertically downwards to the area directly above the umbilicus The incision is carried farther through the linea alba The peritoneum is exposed to the right or preferably to the left If previous studies indicate the urgency for total gastrectomy and if the distal esophagus is mobile the transabdominal approach is preferable The transthoracic incision is used if there is esophageal obstruction whether the tumor is primary in the stomach or the esophagus (figs 50–53)

(b) Right Paramedian Incision This incision is begun an inch to the right of the xiphisternum It is carried vertically downward to the area 1–2 inches below and to the right of the umbilicus The anterior sheath of the rectus is opened and the muscle is separated from its sheath so far as the middle line The posterior sheath of the rectus is thus exposed and incised as well as the underlying transversalis fascia and peritoneum for the whole length of the incision

(c) Right Transrectus or Muscle Split Incision This commences over the right

costal margin and continues vertically downwards at the junction of the inner and middle thirds of the upper part of the *right rectus* muscle for about five inches All these structures in the line of incision are divided, including the muscle itself

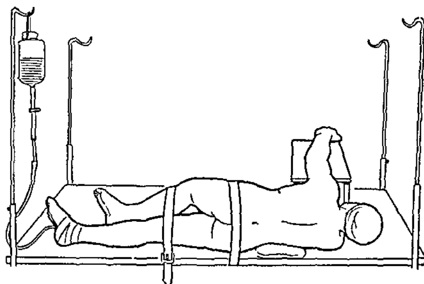


Fig 50—Position of patient for left lateral thoracotomy incision in esophageal or esophagogastric surgery

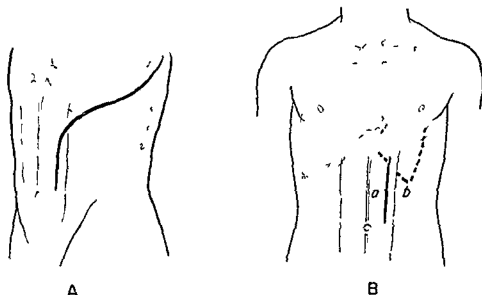


Fig 51—A Combined laparothoracotomy incision B Solid vertical line (a) shows upper left rectus incision Dotted line (b) indicates Baudet Navarro incision utilizing rib flap for lower esophagus or gastric cardia

(d) Left Paramedian Incision This approach is similar to the right paramedian one but passes to the left instead of to the right of the middle line It is carried out where the cancer is high up on the lesser curvature and in order to afford easier approach to the cardiac end of the stomach.

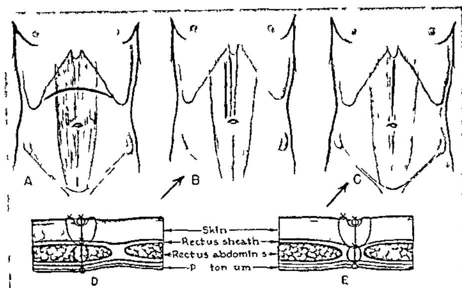


Fig 52 —A Upper abdominal transverse incision with a moderate upward curvature An excellent exposure is obtained B A right paramedian incision Inadvisable for high gastric surgery C Upper midline incision Does not give adequate exposure D Closure of midline incision E Closure of paramedian incision

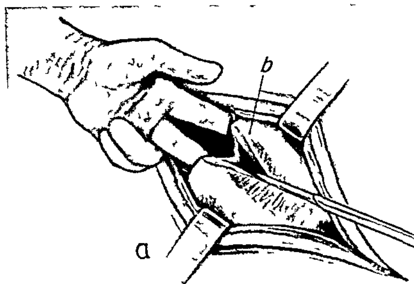


Fig 53 —(a) Costal arch severed with guidance of two fingers inserted intra abdominally (b) Division of cartilaginous costal arch intercostal muscles and pleura

(e) Transverse Incision The transverse epigastric incision is customarily made by some surgeons

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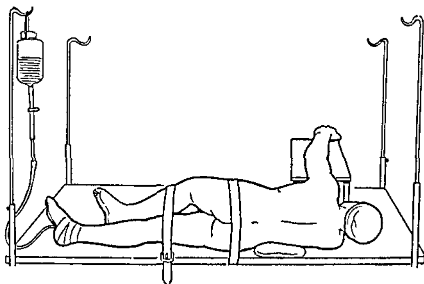


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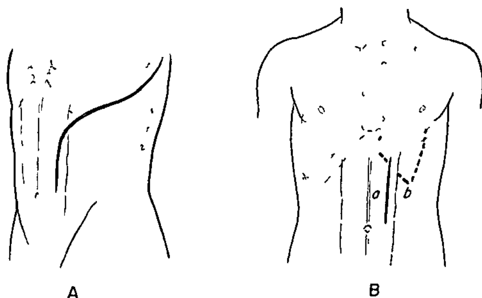


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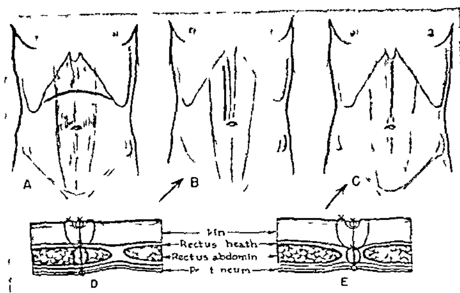


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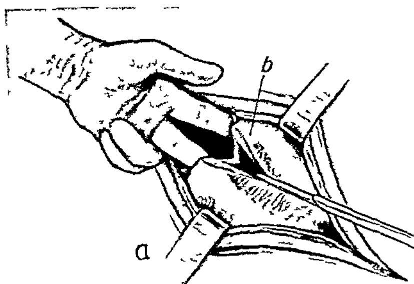


Fig 53 —(a) Costal arch severed with guidance of two fingers inserted intra abdominally (b) Division of cartilaginous costal arch intercostal muscles and pleura

(e) Transverse Incision The transverse epigastric incision is customarily made by some surgeons

General Technics in Total Gastrectomy

There are many modifications of technic and approach for total gastrectomy but the following are usually carried out

(a) Esophageal duodenostomy
(b) Esophagojejunostomy, utilizing a double loop
(c) Esophagojejunostomy, utilizing a single loop

The two avenues of approach are

(a) Abdominal, for esophagojejunostomy
(b) Transpleural—splitting the diaphragm and drawing the cardiac end of the stomach into the pleural cavity

The main difficulties of the operation can be summarized as follows

(a) Great depth of the esophagus and consequently its limited exposure even after reflection of the left lower costal cartilages
(b) Brevity of the sub diaphragmatic part of the esophagus
(c) Absence of a serous coat on the posterior aspect of the esophagus
(d) Friability of esophageal walls
(e) Tendency of esophagus to retract into posterior mediastinum

The general principles on which gastric resection is based are

(a) Preliminary mobilization of duodenum
(b) Complete hemostasis
(c) Aspiration of gastric contents
(d) Deflation of the stomach
(e) Separate suture for each layer of the gastric and jejunal walls
(f) Selection of proper method of gastrointestinal anastomosis to meet requirements of the operation

Total gastrectomy is sometimes accomplished in two stages In the first a long loop of jejunum is placed anterior to the stomach and the summit of the loop is sutured to the diaphragm contiguous to the esophageal opening with one or two sutures of black silk the ends of which are *left dangling for subsequent identification* An entero anastomosis then has to be effected at the base of the long loop The two limbs of the loop are sewn together except for the last two inches The abdomen is closed The second stage that of gastrectomy, is accomplished about a week later The summit of the loop is loosened by withdrawal of the black silk suture before the gastrectomy is begun

ESOPHAGOJEJUNOSTOMY

Moynihan s Operation

(1) Midline abdominal incision 3 inches in length for exploration and enlarged to 8 inches
(2) Field of operation isolated by hot moist pads
(3) Two long clips applied to left gastric artery at its origin from celiac artery
(4) Artery divided and proximal end ligated
(5) *Upper and lower coronary groups of glands* detached downwards toward the stomach by gauze stripping
(6) Cardiac end of the stomach also denuded by gauze stripping

(7) Gastrohepatic omentum divided after ligature so close to liver as possible until upper border of pylorus is reached

(8) Exposure of pyloric artery and gastroduodenal artery by gauze stripping

(9) Pyloric artery ligated and divided (figs 51–55)

(10) Exploration of area posterior to pylorus and down to lower border of duodenum

(11) Opening made in great omentum (fig 56)

(12) Blade of clamp passed upwards through this opening posterior to duodenum to appear above pylorus

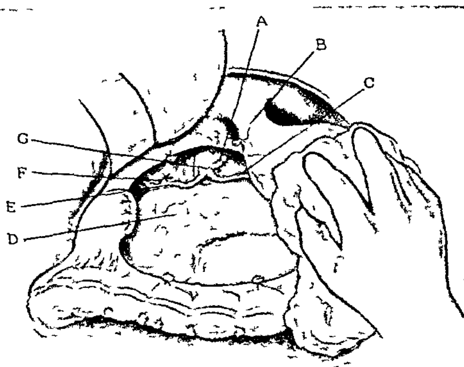


Fig 54 —Exposure of celiac artery and branches A Left gastric B Esophagogastric junction C Splenic artery D Pancreas E Hepatic artery F Right gastric artery G Celiac artery

(13) Second clamp (rubber covered blades) applied distal to previous one and duodenum cut between the two

(14) Single strong catgut suture passed through proximal part of duodenum and round clamp to immobilize clamp

(15) Distal end of duodenum then closed by continuous catgut suture with inclusion of all coats and with double layer Pagenstecher thread sutures above (fig 57)

(16) Clamp attached to proximal part of duodenum now covered with gauze pad and elevated leftward thus thoroughly exposing gastroduodenal artery Artery ligated and divided

(17) Gastrohepatic omentum divided along whole length of greater curvature at a distance from stomach of from one to two inches, glands remaining attached to stomach

(18) Stomach now being freed gentle traction is made on esophagus until about one inch is visible below diaphragm (fig 58)

(19) Transverse mesocolon divided in avascular area

(20) Upper loop of jejunum drawn through this opening

(21) Selection of area on summit of this loop about 8 inches from the duodeno jejunal flexure, for anastomosis

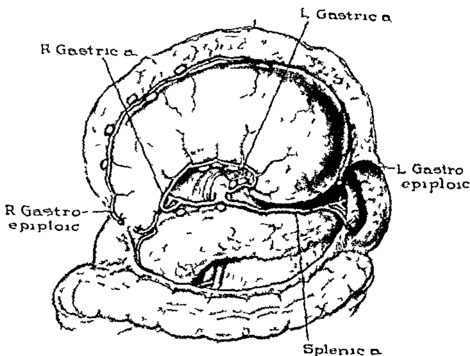


Fig 55 —Blood supply of stomach viewed from below

(22) Extent of about two and one half inches of jejunal loop placed transversely along a line directly posterior to esophagus (In general decision as to whether to form a retrocolic or an antecolic anastomosis depends in the main on the length of jejunal mesentery but in most instances an antecolic anastomosis is greatly to be preferred Then a long afferent jejunal loop is formed of at least 10 to 15 inches in length)

(23) Anastomosis by introduction of eight light interrupted sutures between this selected area of jejunum and esophagus Part of the circumference of jejunum used is that on surface which is now posterior about three-quarters of an inch from the mesenteric attachment

(24) Sutures inserted into esophagus which is further exposed by forcible traction downward

(25) Stomach wrapped in hot laparotomy pads which also serve as tractors upon esophagus (Retention of the stomach until completion of the posterior rows of

sutures is preferable as a rule, to its earlier removal and use of a clamp on the cut end of the esophagus)

(26) Eight interrupted sutures inserted until the posterior half of the esophagus in its entirety is securely attached to jejunum Anterior to these sutures continuous suture introduced from left to right

(27) Anterior to the continuous suture small opening is made into esophagus and into jejunum at extreme left of attachment A continuous through and through Pagenstecher thread suture now placed and a few turns of the needle taken until the whole length of the small openings made are united

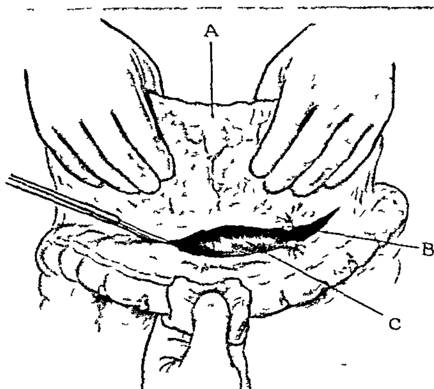


Fig 56—Removing great omentum from transverse colon A Great omentum B Ligation of vessel C Pancreas

(28) These openings enlarged from left to right and in the process cut edges are sutured by the same continuous stitch

(29) After complete posterior part of esophagus is divided it is sutured to the aperture in the jejunum (fig 59)

(30) Procedure repeated around anterior wall of esophagus stitch being changed to the loop on the mucosa variety

(31) The outer continuous suture previously and temporarily laid aside taken up and continued round anterior surface of the esophagus and jejunum to starting point

(32) Suture line now complete

(33) A few anterior sutures placed to anchor jejunum and esophagus to diaphragm

(34) Great omentum turned upwards over surgical area

(35) Abdomen closed

(In certain examples of cancer of the stomach particularly in diffuse leather bottle stomach when the intra abdominal part of the esophagus may be unusually long Moynihan's method of using the mobilized stomach as a tractor is not essential Instead the involved esophagus may be doubly clamped and cut away before proceeding with the anastomosis)

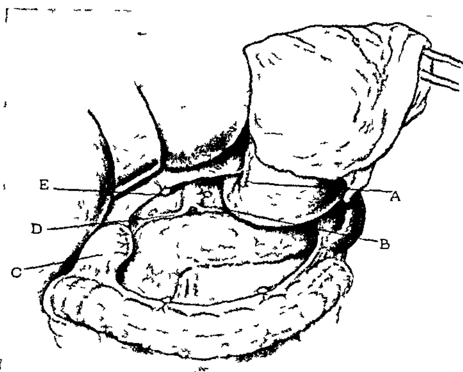


Fig 57—Duodenal stump closed Stomach almost completely mobilized A Left gastric artery B Splenic artery C Duodenal stump D Hepatic artery E Right gastric artery and vein

Moynihan Technic II

(1) Abdomen explored through long left paramedian incision This commences over lower part of sternum and proceeds downward to left of xiphisternum then slightly outward to junction of inner and middle thirds of left rectus muscle and downwards on this plane until it reaches area about two inches below and slightly to left of umbilicus

(2) Inner border of left rectus muscle dissected free from its sheath and retracted widely outwards the posterior sheath of this muscle and peritoneum being incised from costal margin for whole length of wound

(3) If better exposure of esophagus becomes exigent xiphisternum is removed and left costal margin reflected as in Marwedel technic The sixth seventh eighth

and ninth costal cartilages are mobilized to allow a wide retraction to the left and adequate exposure of esophagus and cardia

(4) Pads placed at margins of incision and wound is protected after which it is widely retracted by means of large self retaining retractor

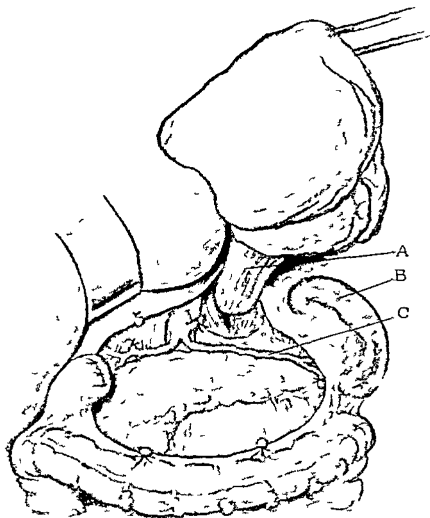


Fig 58 —Stomach and lower esophagus mobilized A Esophagus B Spleen C Splenic artery

(5) After stomach and surrounding organs have been carefully examined and decision is made to carry out total gastrectomy the operation is begun by separating great omentum from transverse colon

(6) Right and left gastroepiploic arteries tied near their origin

(7) Pyloric artery secured and divided between strong ligatures

(8) Gastrohepatic omentum severed so close to liver as possible, until upper third of lesser curvature is reached

(9) Pylorus and first part of duodenum mobilized

(10) Duodenum crushed three quarters of an inch from pylorus, divided and distal end securely closed and invaginated

(11) Gastrosplenic omentum separated from spleen

(12) Stomach drawn forcibly over left costal margin so that left gastric artery is tautened and ligature applied close to point where it arises from the coeliac axis

(13) After division of left gastric artery loose fatty tissues and glands in area of right border of esophagus and upper third of lesser curvature drawn downwards in their entirety Extreme care must be taken in ligaturing left gastric artery not to injure right border of esophagus or include it in mass ligature

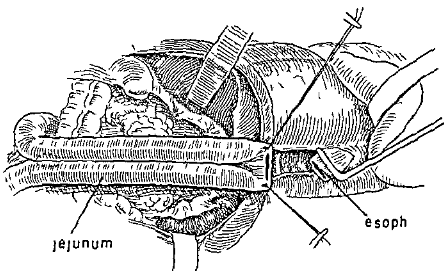


Fig 59 —Esophagojejunostomy and jejunojejunostomy following total gastrectomy

(14) After left gastric artery has been divided between ligatures many filamentous bands on inferior aspect of esophagus circumspectly cut to permit further mobilization

(15) Esophagus freed from its diaphragmatic foramen and from last inch or two of posterior mediastinum

(16) Inverted T incision made through peritoneum covering anterior surface of esophagus

(17) The two peritoneal flaps are retracted and dissected with gauze pressure

(18) On approaching esophageal opening slight blunt finger dissection made around opening allowing esophagus to be gently drawn a little farther downwards into abdominal cavity

(19) As a farther inch or two of esophagus appears the left vagus nerve is seen (The right one is to be found on posterior aspect of esophagus) Both vagi are infiltrated with 1 per cent novocaine and divided, after which esophagus can be drawn down even farther

(20) Proximal jejunum is anastomosed to esophagus (without aid of clamps) as in Moynihan I operation

(21) At completion of operation an Einhorn tube passed through nostril and led through efferent limb of jejunum and used for feeding purposes during first few days after operation

Esophagojejunal Anastomosis

Graham Technic

(1) Patient on his right side operating table tilted 10 degrees backward Right knee bent and arms brought overhead and pelvis strapped to table

(2) Left upper rectus muscle splitting incision from seventh costal cartilage to umbilicus

(3) Peritoneal cavity opened and explored

(4) Gastric tumor palpated size and mobility gauged search made for metastases to regional nodes liver and adjacent organs

(5) Liver inspected and palpated to discover the presence or absence of metastases Involvement of only the tail of the pancreas does not suggest inoperability Lymphatic glands in the various groups must be carefully examined

(6) Abdominal incision extended over costal arch and then continued along the seventh or eighth rib to interscapular area Underlying rib resected subperiosteally from its neck to costochondral junction

(7) Costal arch transected

(8) Pleura incised

(9) Phrenic nerve injected or crushed at cardiophrenic angle to paralyze dia phragm

(10) Diaphragm radially incised from the costal margin to esophageal hiatus

(11) Pleuroperitoneal cavities joined

(12) Inferior pulmonary ligament cut

(13) Lung retracted medially toward Truesdale s esophageal triangle (heart, diaphragm and aorta)

(14) Mediastinal pleura incised in this triangle a short distance along lower one third of esophagus

(15) Finger passed beneath esophagus

(16) Esophagus mobilized by blunt and scissors dissection at least two inches above tumor

(17) Spleen removed if necessary and if its pedicle or belly is involved in tumor Reflect spleen medially to expose posterior surface and true pedicle

(18) Divide lienorenal ligament

(19) Ligate splenic artery first and vein separately

(20) Return spleen to its bed

(21) Divide pre splenic fold and gastrosplenic ligament

(22) This maneuver exposes ligated splenic vessels anteriorly and their division is easily accomplished (Lahey stressed importance of total removal of omentum with stomach and spleen)

(23) Stomach completely mobilized from its esophageal junction down to pylorus by division of gastrohepatic and gastrocolic ligaments

(24) Left gastric artery divided near celiac artery

(25) Right gastric and right gastroepiploic vessels divided near pylorus

(26) Left gastroepiploic vessels ligated and severed

(27) Stomach transected in area of pylorus between Wangensteen clamps and rubber sheet or gauze wrapped around cut end of proximal part of stomach

(28) Duodenal stump closed with two rows of inverting continuous 000 chromic catgut sutures and one layer of interrupted 0000 silk Halsted sutures

(29) Stomach reflected cephalad

(30) Vagi divided near cardioesophageal junction

(31) About twenty four inches from ligament of Treitz draw up loop of jejunum either ante or retro colically and place near non cancerous part of esophagus

(32) Esophagus anchored to jejunum with interrupted silk sutures

(33) Esophagus placed atop of distal jejunal loop and secured there with several silk sutures

(34) Supporting sutures also placed between jejunum and diaphragm

(35) Stomach again reflected superiorly

(36) Open anastomosis effected between esophagus and distal jejunal loop using outer posterior and outer anterior row of interrupted 0000 silk, and inner posterior and inner anterior row of interrupted 000 gastrointestinal chromic catgut

(37) During anastomosis esophagus transected above tumor

(38) Levine tube inserted into distal jejunal loop

(39) On completion of anastomosis proximal jejunal loop folded over onto esophagus and distal jejunal loop and anchored to those structures with interrupted silk

(40) Jejunal loop sutured to mediastinal and parietal pleura to obviate tension on anastomosis

(41) About six inches below esophagojejunal anastomosis open enteroenterostomy accomplished between proximal and distal jejunal limbs

(42) Diaphragm closed with mattress sutures around intrathoracic jejunal loops

(43) Thorax closed in layers around two catheters for under water drainage

(44) Abdominal wound closed without drains

Richard H Sweet[166] suggested that where the two structures cannot be brought together by ordinary means the difficulty may be obviated in the following manner

> The usual transthoracic approach through the bed of the ninth rib is made After removal of the entire stomach and closure of the duodenal stump an opening should be made in the transverse mesocolon at a convenient point taking care to avoid the middle colic vessels The highest jejunal loop is then drawn up through the mesocolon and in the majority of cases can be pulled no farther than one or two centimeters above the level of the diaphragm In every case the reason for this is that the vessels of the mesentery are too short to allow the loop to go beyond that point although the bowel itself if freed from the pull of the mesenteric structures can be drawn up to any level In some cases a slight amount of relaxation of the pull results from dividing the ligament of Treitz This is rarely sufficient to make an appreciable difference If however the main artery which supplies the proximal jejunal loop is sought out and cut between ties close to its origin from the superior mesenteric artery and if the vein is treated likewise the pull of the mesentery on the loop is greatly relaxed and its apex can be advanced as much as three inches into the chest above the level of the diaphragm

McNeer Sunderland and McInnes and others[166a] described a technic of radical total gastrectomy incomplete pancreatectomy and splenectomy They recommended this radical operation as an approximation to the ideal of an en block resection of

gastric cancer One of the main advantages of the operation is that it facilitates mobilization and rotation of the pancreas with clear visualization of the splenic vessels at their origin

McNeer and Bowden[166b] state

> Few will deny that in the treatment of gastric cancer total gastrectomy not only permits the removal of the maximal amount of stomach contiguous to the tumor but also favors a more complete removal of the regional lymph nodes particularly those adjacent to the gastric cardia and celiac axis

ESOPHAGODUODENOSTOMY

This operation is inadvisable as a rule[1]

After the abdomen has been opened the stomach is mobilized in the usual manner The duodenum is severed directly distal to the pylorus if this area is uninvolved The duodenal stump is held in a curved forceps and is *not* closed unless it is clear that union of the esophagus and duodenum cannot be accomplished without tension The stomach freed until it is attached only to the esophagus is emptied by suction and a clamp is placed across the proximal part of the cardia before the stomach is reflected upward and outward at the cephalad end of the incision This is done in order to prevent regurgitation of gastric contents into the esophagus The end of the duodenum is then approximated to the esophagus to ascertain whether it will lie in this position freely and without tension

(The duodenal stump can be closed by the Parker Kerr basting stitch technic, reinforced with silk Lembert sutures or the De Petz clamp may be utilized The peripancreatic capsule is sutured over the stump The open pyloric segment is circumspectly enveloped with a laparotomy pad)

If there is tension the peritoneum lateral to the duodenum may be incised for a few centimeters and gentle mobilization of the duodenum can then be accomplished If the duodenal stump still does not rest freely approximated with the esophagus this variety of anastomosis should be discontinued the duodenal stump being closed and esophagojejunostomy carried out instead

If it is discovered that the duodenum rests in contact with the esophagus when all traction is removed the anastomosis between the two structures is effected First two or three interrupted stitches of silk are placed between the posterior aspect of the duodenum and the pancreas These stitches serve to fix the duodenum in its approximation to the esophagus

A three row suture technic is accomplished It consists in placing an outer row of interrupted stitches of silk followed by a continuous row of silk and finally a row of surgical gut on the mucosa

The posterior rows are placed first from without inward so that the second row is last of the posterior suture lines to be completed

The esophagus is left intact until the posterior mucosal row is started and then an incision is made transversely across the posterior wall of the esophagus

The esophagus is now emptied by suction The clamp is removed from the duodenum and the crushed tissue is trimmed away

After the posterior mucosal row of sutures has been completed the anterior wall

of the esophagus is incised gradually as the first anterior mucosal suture line is completed The outer two rows of sutures then are placed anteriorly

After completion of the anastomosis the duodenum is anchored in its new position anteriorly

SUBTOTAL GASTRECTOMY

Transthoracic Approach The advantages of the transthoracic approach in cancer of the cardia and lower third of the esophagus are

(1) More direct accessibility

(2) Better exposure of the involved structures within abdomen

(3) Ability to deal with cancerous involvement of the diaphragm and lower esophagus

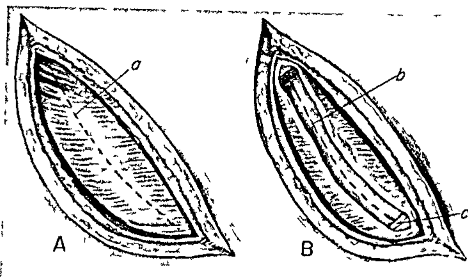


Fig 60—A Division of serratus anterior and latissimus dorsi muscles over ninth rib (a) B Line of incision through pleura (b) along upper margin of rib to avoid trauma to intercostal vessels and nerves (c)

The disadvantages are

(1) Possibility of infection in the mediastinum and pleura

(2) Longer surgery time

The transthoracic approach obviously varies with the site of the cancer The bed of the seventh rib is the best approach for the higher lesion of the esophagus the bed of the eighth for esophageal cancer situated above the hiatus and the bed of the ninth for a gastric carcinoma

The full thoraco abdominal incision is begun at the middle of the left rectus abdominis and passes backwards to cross the costal margin at the tip of the ninth costal cartilage, it follows the ninth rib back to the outer border of the erector spinae muscle where it curves upwards for two inches The muscles are then divided The posterior end of the eighth rib is removed and the whole of the ninth at the anterior end The costal cartilage is dissected from the muscles The pleura and peritoneum are opened (figs 60 65)

The diaphragm is split back towards the hiatus from the anterior end of the pleural

incision The vessels in the diaphragm are caught and transfixed It is convenient to use these sutures as retractors the anterior ones being sewn to the external oblique muscle on the edges of the incision the posterior ones being left long and anchored to the surface by artery forceps Fixation of the diaphragm in this manner not only makes retractors unnecessary but allows proper action of the right dome of the diaphragm and prevents its pull from kinking the inferior vena cava and obstructing blood return to the heart (figs 66–78)

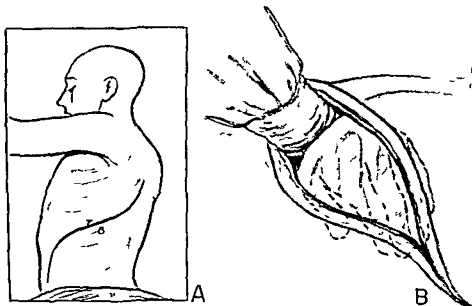


Fig 61 —A Patient on right side with slight posterior inclination Incision begun over left rectus then crosses costal arch along seventh intercostal space to area between vertebral column and left scapula B Abdomen explored through abdominal incision to discover extent of involvement.

Cancer of the Lower Third of the Esophagus and Cardia of the Stomach Abdominothoracic Approach The patient is securely placed on his right side with the left upper arm pulled well forwards and hips and knees flexed A low bridge under the right lower ribs facilitates exposure but is lowered for wound closure The operation table is made to tilt slightly dorsal in the early part of the operation and ventrally for esophageal anastomosis

A transverse abdominal incision is made starting midway between umbilicus and xiphisternum and passing just over the left costal margin This is deepened to open the peritoneum in the same line The growth and any extensions are palpated The liver retroperitoneum and pelvis are especially examined for metastases If it appears that resection is feasible the abdominal incision is extended into the thorax

With the left hand in the abdomen the eighth intercostal space is identified and over this space an incision is made from the costal margin to the posterior axillary line This incision is deepened through the muscles and intercostal space to open the pleural cavity The costal margin is also enlarged

A self retaining abdominal retractor is placed in the wound and spread slowly The diaphragm is now incised from its periphery down to the esophageal hiatus A few vessels in the muscle and finally the inferior phrenic vessels are ligated The abdominal retractor is spread widely open

If the growth is localized in the area of the cardiac orifice and the sub pyloric glands are not enlarged, a resection of the upper three quarters of the stomach is adequate, but if the tumor is mid gastric or involves over one third of the stomach a total gastrectomy should be carried out

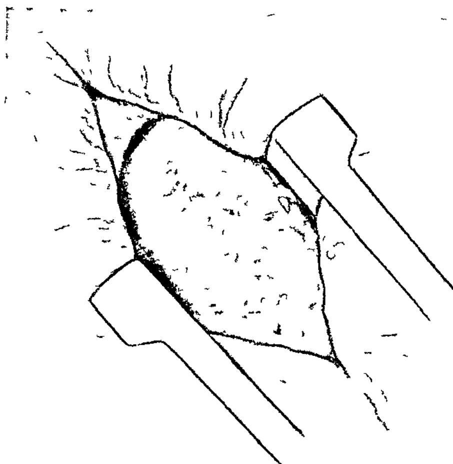


Fig 62 —Chest wall spread by Finochietto retractor over gauze pads to protect wound edges

The spleen is routinely removed in tumors of the upper stomach in order to ablate the splenic group of lymph glands

The gastrectomy is commenced by separating the transverse colon from the great omentum up to the splenic flexure The spleen is now elevated forwardly and the splenic and left gastro epiploic vessels are divided at the pancreatic tail removing so many lymph nodes as possible with the spleen The lateral peritoneum of the lesser sac is divided still higher in order to free the entire greater curvature of the stomach up to the esophagus One or more vasa brevia are seen which run from the course of the splenic artery and require division and tying The lower esophagus is freed from

the hiatus in the diaphragm (If this part of the esophagus is involved a ring of diaphragmatic muscular tissue can be left attached to the esophagus and also removed with the growth) The glands around the cardia must be removed with the stomach

The upper limit of the gastrohepatic ligament is now discovered and separated from the liver and from the cardia downwards to the area of the hepatic artery

The stomach is rotated over to the right The left gastric vessels are seen dissected and divided close to the pancreas

The dissection is now continued to the pyloric part of the stomach If this part is to be preserved then the right gastric and right gastroepiploic vessels are divided directly to the right of the site of contemplated gastric section

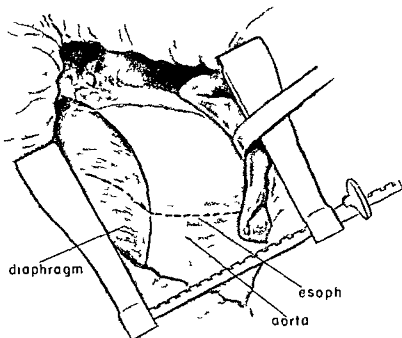


Fig 63 —Exposure through thoracic approach showing (dotted line) incision through mediastinal pleura to reveal esophagus

The stomach is then divided between Payr crushing clamps

The mediastinal pleura overlying the lower esophagus is now divided and the ligamentum latum pulmonale likewise for 5 or 6 centimeters The level of the division of the esophagus is determined It should be some 6 cm above the growth The esophagus is gently freed for 3 to 4 cm above this area and mediastinal glands or cellular tissue also dissected and elevated with the esophagus

The stomach spleen and omenta are now lifted upwards out of the wound The esophagus can be divided between fine clamps and the growth removed

Continuity can be restored either by end to end esophago gastric anastomosis or by closing the cut end of the stomach and implanting the esophagus into an opening

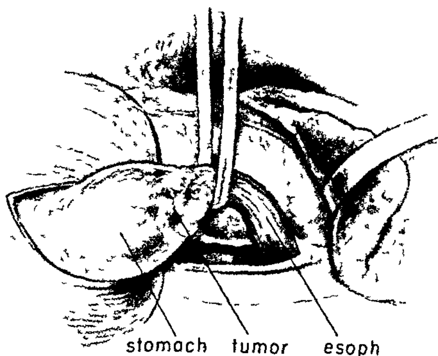


Fig 64 —Transthoracic exposure of cancer of cardiac end of stomach Diaphragm has been severed

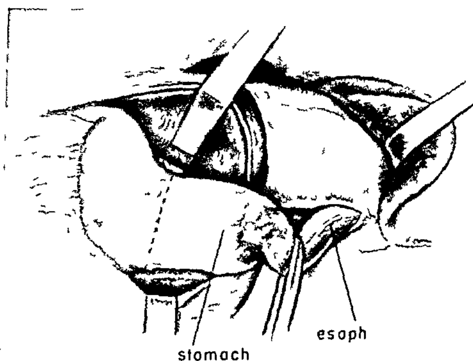


Fig 65 —Cancer of stomach at junction with esophagus showing exposure after dividing diaphragm Line of transection shown in dotted line

made in its anterior wall In either case the pyloric end of the stomach must be carefully mobilized It is freed from the colon and from the pancreas and adhesions to the parieties or gallbladder or duodenum are freed The stomach can then be lifted up until its cut end approximates the esophagus If end to end anastomosis is contemplated then a short part of each extremity of the cut end of the stomach is closed until the residual opening equals the diameter of the esophagus A continuous fine catgut stitch unites the posterior sero muscular layer of the stomach to the muscular layer of the esophagus A suture taking in all the coats is now placed between the

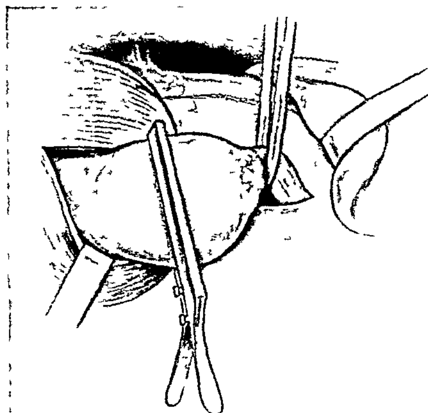


Fig 66 —De Petz clamp applied preparatory to resection of involved section of stomach

posterior and then the anterior layers of the stomach and esophagus using fine interrupted silk sutures and taking great pains to get a good bite of esophageal mucosa in each stitch The catgut continuous suture is now passed around the esophagus in such a way as to suture each protrusive corner of the stomach against the side of the esophagus A few interrupted reinforcing sutures of silk complete the anastomosis

The Billroth II Operation In this operation the cut ends of the stomach and duodenum are closed and the jejunum in an antecolic long loop anastomosis is united to the lowest part of the stomach

All subtotal gastrectomies are modifications of the Billroth I and II technics

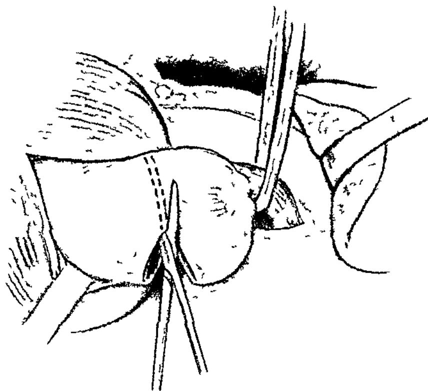


Fig 67—Transthoracic resection of stomach above severed diaphragm Transection of stomach preparatory to removal of proximal part

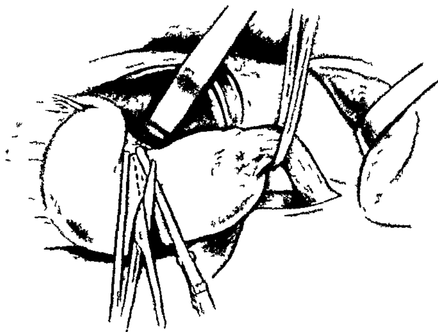


Fig 68—Intra abdominal transection of stomach

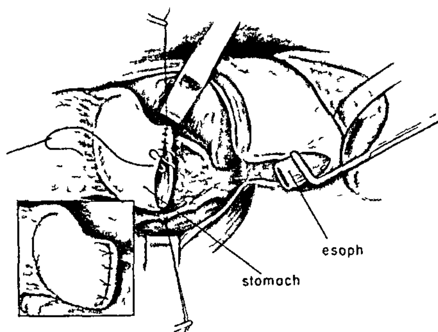


Fig 69 —Esophagogastrostomy

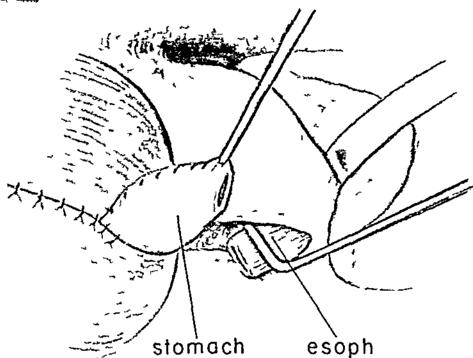


Fig 70 —Sweet's technic in gastroesophagostomy Opening in diaphragm closed

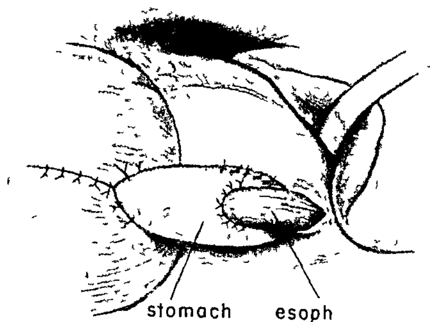


Fig 71 —Another view of the Sweet operation

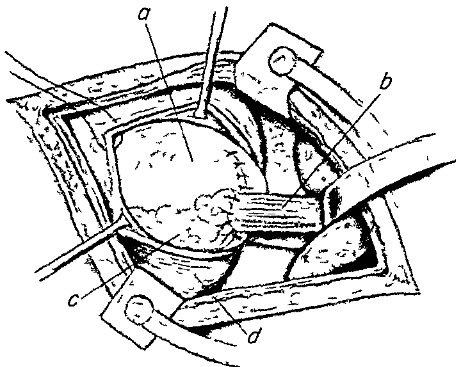


Fig 72 —Gastroesophageal anastomosis completed Stomach sutured to diaphragm Anterior part of diaphragm in process of suturing (a) Stomach (b) Esophagus (c) Omentum (d) Diaphragm

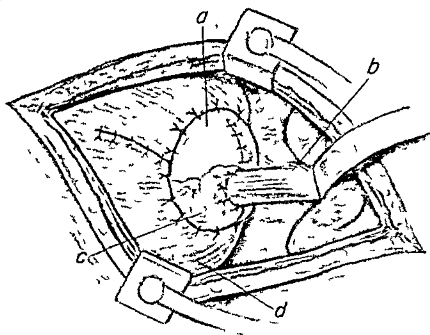


Fig 73—Stomach attached to diaphragm with interrupted sutures and diaphragmatic margins approximated (a) Stomach (b) Esophagus (c) Omentum (d) Diaphragm

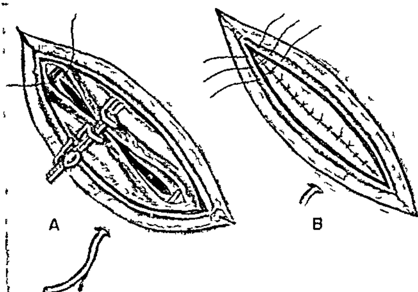


Fig 74—A No 24 Foley catheter inserted through stab wound in tenth intercostal space Incision then closed with interrupted sutures first through pleura Eighth and tenth ribs brought closer with Bailey rib approximator when pleural sutures are tied B Inter costal muscles latissimus dorsi and serratus muscles sutured with interrupted strands Skin closed with silk

The original Billroth II operation consisted of a gastrojejunal anastomosis anterior to the colon The gastroenterostomy was effected several days prior to the removal of the cancer because the patient was too seriously ill at the first operation to undergo a complete one Because a functioning gastroenterostomy was already present the cut ends of the duodenum and stomach were closed by inversion

The original Billroth II technic was therefore an antecolic, side to side or lateral gastrojejunostomy

The many modifications of the Billroth II technic, according to Pack, are all based on six fundamental points, three of which are of major importance and three of less significance

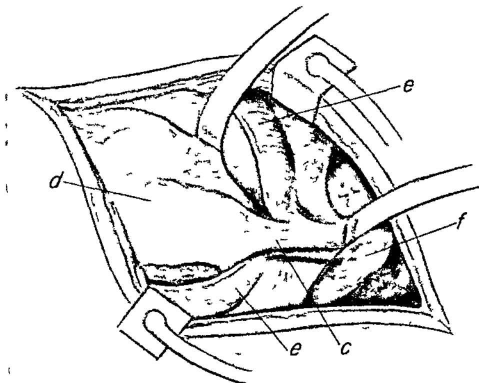


Fig 75 —Stomach mobilized through combined abdominothoracic approach (c) Esophagus (d) Stomach (e) Diaphragm (f) Lung

The following are the major points (1) whether the anastomosis is made in front of or behind the transverse colon (anterior versus posterior gastrojejunostomy) (2) whether the open end of the stomach is used for the repair or this is closed and a new gastroenterostomy stoma is created (end to side versus side to side union) (3) what direction is given to the jejunal loop in its alignment with the stomach (isoperistaltic versus antiperistaltic anastomosis)

The secondary and remaining considerations are as follows (4) whether the entire cut end of the stomach or but a portion is utilized (5) whether or not a supplementary jejunojejunostomy is added to the gastrojejunostomy and (6) whether the jejunum is used in the form of a loop or is severed and the anastomosis made of the en Y type [165]

The basic requirements of the operation are

1 Correct pre surgical preparation

2 Perfect technic which includes (a) scrupulous cleanliness (b) absolute hemostasis, (c) carefully approximated suture lines which are sufficiently reinforced with interrupted sutures (d) correct mechanics

3 Excision of growth with wide margin of normal tissue circumjacent to diseased area This also includes (a) removal of the whole of the first part of the duodenum (b) removal of the whole of the lesser curvature of the stomach (c) removal of at least half of the greater curvature of the stomach (d) removal of regional glands such as the supra pyloric retropyloric and infra pyloric the glands along the lesser curvature—the lower coronary and upper coronary the right paracardial glands and

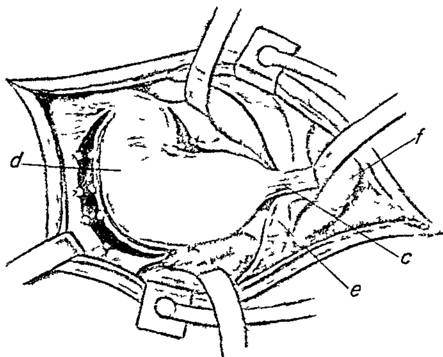


Fig 76—Exposure through abdominothoracic incision after division of diaphragm Gastric vessels already ligated (c) Esophagus (d) Stomach (e) Diaphragm (f) Lung

those along the greater curvature—the right gastroepiploic (e) removal of the greater part of the whole of both omenta

The great omentum may be detached from the colon and removed This is considered by many surgeons as an important step in the operation

Cancer of the gastric cardia according to Pack and McNeer[167] can be removed by four different technical means namely

(1) Abdominal total gastrectomy

(2) Abdominal cardiectomy or proximal subtotal gastrectomy (laparo thoracic resection) or

(3) Laparo thoracotomy

(4) Transthoracic or transdiaphragmatic esophago gastrectomy (subtotal or total)

"Among factors influencing the surgeon to select one of these procedures as best suited for the individual case are the involvement or freedom from involvement of the esophagu the regional localization of the cancer strictly to the cardia or fundus the extension of the carcinoma for great distances along the lesser curvature the presence of diffuse sero al in vasion, peritoneal carcinosis of the lesser omental bursa and adherence to an invasion of neighboring organs"

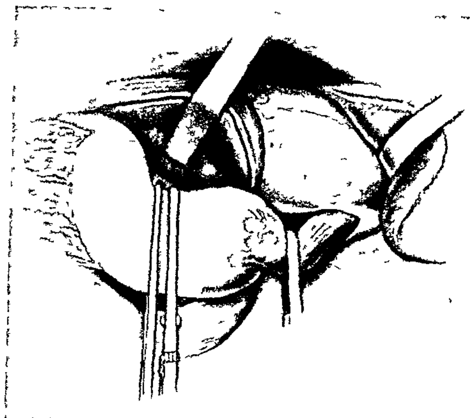


Fig 77—Mobilization of stomach and lower esophagus after ligation of left gastric artery and vein and left gastroepiploic vessels

The essentials of the Billroth II technic are the duodenum is closed blindly and the stump of the stomach is closed completely after which the stomach is anastomosed to a loop of jejunum side to side

(1) Midline abdominal incision extending from the ensiform cartilage to the umbilicus

(2) Before the peritoneal cavity is opened laparotomy pads are fixed to the skin margins Edges of the wound are widely retracted

(3) Abdomen explored and viscera packed away from the surgical field

(4) Line of contemplated resection ascertained—at least one or two inches from diseased area (to left) and away from enlarged lymph nodes

(5) Fixation of stomach may be caused by inflammatory adhesions and does not necessarily preclude resection Anchorage to anterior edge of liver may similarly be

caused by inflammatory adhesions and even where it is the result of direct spread of growth a small margin of liver may be excised to facilitate mobilization of stomach prior to resection

(6) In certain examples where growth is anchored to pancreas it is possible to shave away part of gland with attached part of stomach

(7) Wide fixation and extensive involvement of pancreas indicative of inoperability

(8) In certain examples where transverse colon is site of invasion either directly or through medium of great omentum it may be possible to resect part of transverse colon together with stomach and great omentum

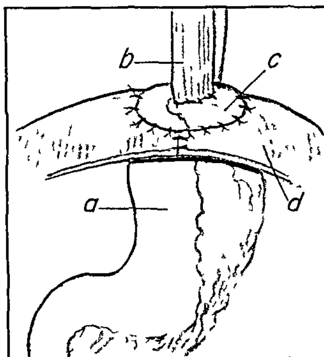


Fig 78—Details of completed operation prior to closure of abdominothoracic wound (a) Stomach (b) Esophagus (c) Omentum (d) Diaphragm

(9) Enlargement of lymphatic glands does *not* necessarily entail involvement by cancer

(10) Separate stomach from its attachments either through lesser omentum or through gastrocolic omentum

(11) Gastrocolic separation begun by doubly ligating and dividing left gastro epiploic vessels about middle of greater curvature and more laterally to left if necessary

(12) A bit of stomach wall included within bite of needle

(13) Leave these ligatures long attached to clamps to be used as tractors

(14) Gastrocolic omentum doubly ligated and divided

(15) Continue this maneuver to right so far as duodenum

(16) *Avoid injury to middle colic vessels these supply transverse colon and if injured gangrene of bowel follows*

(17) Keep close to upper border of transverse colon to include all involved lymph nodes

(18) Isolate and ligate right gastroepiploic artery where it arises from gastroduodenal artery

(19) Free pylorus from pancreas posteriorly

(20) Doubly ligate and divide left gastric artery

(21) Stomach divided between clamps and reflected to right

(22) Parts of pancreas, if involved, removed, care being exercised not to injure ducts of the organ

(23) Lesser omentum (gastrohepatic) divided in same manner as gastrocolic omentum

(24) Large laparotomy sponge, moist, placed posterior to partly detached stomach

(25) Two crushing clamps (Payr variety) are now placed at area of purposed section of duodenum (usually about one inch from pylorus)

(26) Duodenum divided with knife dropped in weak iodine solution keeping close to distal clamp

(27) Second part of duodenum can be mobilized by Kocher's technic An incision 3 cm in length made over peritoneum on lateral border of descending part of duodenum Flap of peritoneum (with second part of duodenum and head of pancreas) is separated from posterior wall by blunt dissection In order to mobilize first part of duodenum additional incision is made over peritoneum of anterior layer of hepaticoduodenal ligament just where this layer joins superior part of duodenum First part of duodenum can then be gently drawn downwards without causing any bleeding

(28) Apply clamp to distal (left) segment of stomach (There are three varieties of clamp used in gastrectomy namely (a) the Friederich Petz clamp (b) crushing clamps or enterotribes—Payr s, Furniss s—and (c) gastrojejunostomy clamps—for example Sherren s of which some are made with strong firm blades and others with soft flexible blades) The rubber covered clamps should always be applied cautiously and gently never firmly enough to prevent bleeding and never so firmly as to damage friable mucosa A suction apparatus should be kept ready during operations upon stomach and is indispensable where anastomosis is carried out without clamps If at operation stomach is found to be distended with fluid it is an easy matter to introduce suction tube into cavity of stomach through a small incision and to withdraw all contents before proceeding with surgery

(29) Wrap detached pyloric end of stomach in a hot laparotomy sponge and turn it over to left of patient

(30) *Proceed with closure of duodenum*

(31) End of duodenum closed with Cushing suture placed over clamp It is not knotted at start

(32) While clamp is gradually withdrawn traction on end of suture (strong chromic catgut) inverts edges of divided duodenum

(33) *Suture now placed along duodenum returning to its starting point and securely tied*

(34) Superimposed sutures may be placed for reinforcing suture line if need be

(35) In first and last bites of suture at right angles to open end of duodenum (Parker Kerr stitch) inversion of duodenum is facilitated

(36) Thorough closure of duodenal stump is of utmost importance (Major technical difficulty in accomplishing subtotal gastrectomy is securing a leak proof closure of duodenal stump Mobilization of several centimeters of duodenum during subtotal gastrectomy is requisite for satisfactory closure of stump To be kept in mind is possible danger of devascularization of stump in carrying out necessary separation of segment to be inverted from head of pancreas

(37) Alternative technic may be achieved by applying two clamps to duodenum distal to diseased part and about one inch apart Divide duodenum with cautery knife Release crushing clamp and ligate crushed ribbon of duodenum with strong chromic catgut Superimpose a purse string suture Reinforce with additional sutures

(38) In either method of duodenal closure a tab of omentum is drawn over duodenal stump and latter fastened to head of pancreas in such manner as to cover any denuded pancreatic surface and to further insure against leakage from duodenum

(39) The gastrojejunostomy now carried out

(40) Elevate and reflect omentum and transverse colon Identify first loop of jejunum by palpating the ligament of Treitz

(41) Pick up loop about 14 to 18 inches from duodenojejunal juncture

(42) Place it anterior to transverse colon and omentum and against divided stomach stoma for anastomosis

(43) Distal end of jejunum must always be at greater curvature of stomach

(44) Allis forceps hold stomach closed after crushing clamps are removed

(45) End to side termino lateral anastomosis is now carried out

(46) First suture introduced this is a Cushing right angle stitch of Pagenstecher celloidin linen (or silk) carried on a straight or curved needle On reaching lesser curvature suture is tied—not locked

(47) Opening made in jejunum

(48) Remove Allis clamps insert an U angle suture and tie

(49) Unite posterior wall of stomach with that of jejunum by continuous suture After emerging on opposite angle continue suture uniting anterior walls of divided viscera by Connell or straight through and through suture

(50) Superimpose last suture line—a seromuscular (Cushing) stitch covering anastomosis (When anastomosing cut ends of stomach duodenum or jejunum three layers—mucous membrane seromuscular and serous membrane—must be separately sutured)

(51) Cleanse surgical area

(52) Loosen clamps

(53) Discard instruments used in anastomosis Don fresh gloves

(54) Protect angles of anastomosis by stitching omentum over it

(55) Close abdomen

Anterior Gastrojejunostomy

Some cited disadvantages Many mistakes are made by surgeons because in their manipulations to bring the jejunum in apposition to the stomach they twist the

(16) *Avoid injury to middle colic vessels, these supply transverse colon and if injured gangrene of bowel follows*

(17) Keep close to upper border of transverse colon to include all involved lymph nodes

(18) Isolate and ligate right gastroepiploic artery where it arises from gastro duodenal artery

(19) Free pylorus from pancreas posteriorly

(20) Doubly ligate and divide left gastric artery

(21) Stomach divided between clamps and reflected to right

(22) Parts of pancreas, if involved, removed, care being exercised not to injure ducts of the organ

(23) Lesser omentum (gastrohepatic) divided in same manner as gastrocolic omentum

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(33) Suture now placed along duodenum returning to its starting point and se curely tied

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(49) Unite posterior wall of stomach with that of jejunum by continuous suture After emerging on opposite angle continue suture uniting anterior walls of divided viscera by Connell or straight through and through suture

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(51) Cleanse surgical area

(52) Loosen clamp

(53) Discard instruments used in anastomosis Don fresh gloves

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(55) Close abdomen

Anterior Gastrojejunostomy

Some cited disadvantages Many mistakes are made by surgeons because in their manipulations to bring the jejunum in apposition to the stomach they twist the

jejunum on its mesentery and then join it to the stomach *If the efferent loop of the anastomosis is made to pass behind the afferent loop along with the omentum and transverse colon then in the presence of distension of either efferent or afferent loop there may be produced a mechanical ileus*

The A A Berg Technic of Subtotal Gastrectomy

(1) *Double ligation of left gastric artery so high as possible*

(2) Posterior aspect of stomach exposed and branches on posterior wall are caught, clamped and separately ligated

(3) After ligation of left gastric artery and vein and its branches index finger of left hand passed behind stomach through lesser retrogastric pouch to advance gastro colic ligament

(4) Ligament is penetrated

(5) *Through opening in gastrocolic ligament left epiploic artery readily seized* between two clamps, divided and ligated

(6) Starting at area of ligation of left epiploic artery gastrocolic ligament below epiploic arch seized in sections between two clamps and divided

(7) When adequate opening has been made in gastrocolic ligament for inspection of retrogastric space transverse mesocolon is carefully separated from posterior wall of stomach As this step is carried out middle colic artery moves away with transverse mesocolon

(8) When separating posterior wall of stomach from transverse mesocolon and pancreas splenic artery superiorly and middle colic artery in substance of transverse mesocolon are avoided

(9) *As transverse mesocolon is separated more and more of gastrocolic ligament is* divided between clamps always below epiploic arch (fig 79)

(10) Dissection approaches gastroduodenal angle in which pancreatic lymph glands are found

(11) Right epiploic artery seized between clamps and divided

(12) Pyloric end of stomach held tense while surgeon divides anterior layer of gastroduodeno colic ligament, thus pushing away hepatic flexure of colon and exposing nodes in gastrohepatic angle

(13) These nodes carefully dissected and their vascular supply caught between clamps (fig 80)

(14) Separation of pyloric end of stomach from head of pancreas thus brought about

(15) Ascending branch of right colic artery and vein where they join superior mesentery vessels are avoided

(16) Vein can readily be evaded by drawing head of pancreas away

(17) Vessels of duodenal angle ligated with hemostatic suture

(18) Rest of vessels of gastrocolic ligament ligated in usual way and transverse colon pushed back into abdomen and protected with pad

(19) Pyloric branch of hepatic artery now ligated directly below pyloric ring

(20) Pyloric artery divided and suture passed on its distal side

(21) Gastric clamp applied to proximal end of stomach, just distal to point at which vessels (left cardiac artery and epiploic artery) were ligated (*Payr clamps* not used because of bulk)

(22) Second clamp applied about 3 cm distal to proximal clamp and wall of stomach now divided

(23) Division commences at lesser curvature parietal and muscular coats of anterior wall are cut through exposing submucous intrinsic gastric vessels

(24) These vessels separately caught by clamps and ligated

(25) Posterior wall now divided and vessels in submucosa exposed and again caught between clamps When all vessels have been seized muscularis and peritoneal coat of posterior wall are divided

(26) Stump of stomach covered with pad so as to prevent soiling and is reflected to right

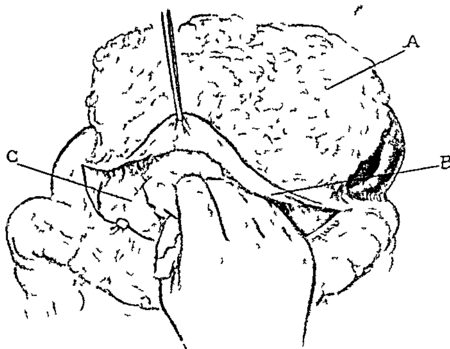


Fig 79—Elevation of posterior wall of stomach from pancreas exposing omental bursa (a) Great omentum (b) Gastrocolic omentum (c) Pancreas

(27) Having mobilized pylorus and first part of duodenum a clean section is made of first part of duodenum below pyloric ring

(28) Clamp not applied to distal stump of duodenum which is left open so that by direct inspection and palpation it is ascertained whether there is any cancer invading duodenal wall

(29) Re establishment of continuity of gastroenteric canal by modification of Billroth II operation

Anterior Polya Operation This is accomplished in approximately the same manner as the posterior Polya however the jejunum is brought up anterior to the colon and is anastomosed to the stomach approximately 12 to 16 cm from the ligament of Treitz

This variety of anastomosis is indicated particularly when resection is unusually high or when the transverse mesocolon is short and excessively fat

Hofmeister Modification of Polya Operation In certain instances it may be advisable to follow the Hofmeister technic The anterior *or posterior* Polya anastomosis however, provides the same mechanical advantages as the Hofmeister procedure if the opening in the jejunum is made somewhat smaller than the diameter of the cut end of the stomach and if the anastomosis is carried out so that the cut end of the stomach "funnels" down to the smaller opening in the jejunum Additional advantages of this procedure over the Hofmeister lie in the saving of time and in the aboli

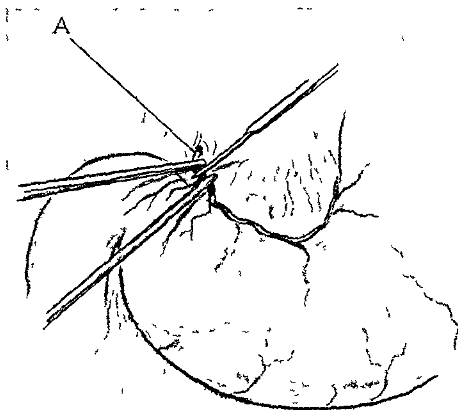


Fig 80 – Ligation of right gastric artery (A) and vein at start of gastrectomy

tion of the angle between the jejunum and the partly closed end of the stomach where leakage may occur

The Hofmeister modification of the Polya operation when it is accomplished is carried out in exactly the same manner as the posterior or anterior Polya operation *with the exception* that a greater part of the stomach at right angles to the lesser curvature of the stomach is removed By this means the circumference of the opening in the stomach which is to be anastomosed with the jejunum is reduced and a valve is formed

Polya Modification of Billroth II (Posterior Anastomosis)

(1) Lesser peritoneal sac explored

(2) Small opening made in gastrocolic omentum well over to left away from lesion and so close to colon as possible

(3) Branches of gastroepiploic vessels doubly clamped and parts of vessels between clamps cut to enlarge opening

(4) Mesocolon carefully drawn aside so that vessels contained within it remain uninjured

(5) Greater curvature mobilized farther by continuance of dissection to area of pylorus so close as possible to transverse part of colon

(6) Inferior gastric lymph nodes and subpyloric lymph nodes included with part of stomach to be resected

(7) Right gastroepiploic vessels can then be clamped ligated and cut

(8) Vessels in area of pylorus ligated and cut close to duodenal wall

(9) After vessels are ligated lesser curvature of stomach is mobilized

(10) Superior border of duodenum held tensely

(11) Small opening made through gastrocolic omentum close to duodenal wall

(12) Hemostats placed across omentum which includes some branches of gastrojejunal artery

(13) Vessels then divided between hemostats and ligated

(14) Gastrocolic omentum thus divided to just beyond distal line of resection

(15) Payr clamp placed on duodenum well beyond pylorus

(16) Rubber covered Doyen clamp placed just proximal to pylorus to prevent drainage of gastric secretion from stomach

(17) After duodenum is divided close to distal clamp stomach is retracted upward and to left

(18) Duodenal stump closed with fine chromic catgut First row of sutures placed over clamp in form of running mattress suture

(19) By gentle traction on two ends clamp can be removed and edges of duodenal stump are inverted

(20) For further inversion same suture material can be utilized in second row of a continuous mattress suture to return to starting point

(21) Several interrupted mattress sutures of fine silk give added security to closure

(22) Stump of duodenum can then be buried in areolar tissue in area of head of pancreas (or available visceral peritoneum) from hepatic flexure of colon and adjacent omentum can be placed over it in such manner as to seal off possible leak from closed omentum

(23) Gentle traction can be applied on gastrocolic omentum to facilitate mobilization of greater curvature

(24) Placement of clamp on left gastric artery aided by forward traction on stomach

(25) Edge of stomach palpated between thumb and index finger and by breaking through gastrohepatic omentum at an area beyond line chosen for resection left gastric artery can be clamped doubly ligated with chromic catgut and cut

(26) Distal part of left gastric artery ligated (after artery is divided with single ligature) and bared musculature on lesser curvature resulting from division of gastrohepatic omentum and left gastric artery is covered

(27) Two or three interrupted sutures are used to approximate adjacent edges of serosa of anterior and posterior walls of stomach

(28) Mobilization of stomach is now completed and rubber covered Doyen forceps can be applied just proximal to purposed line of resection while stomach is held taut in forward position

(29) If stomach is distended with gas or retained contents trocar inserted through divided end of stomach and contents removed by suction before line of resection is finally planned

(30) If decision is for retrocolic anastomosis appropriate part of transverse part of mesocolon is selected in which to make an opening, this part should be avascular and should be situated well to left, so that anastomosis may lie in so nearly a normal anatomic position as possible

(31) Sometimes expedient to attach posterior cut edge of transverse part of meso colon to stomach

(32) Best to attach cut edge of opening in transverse part of mesocolon to stomach *after* anastomosis has been completed

(33) Loop of jejunum approximately 5 cm from ligament of Treitz is selected and brought through opening in transverse mesocolon

(34) Rubber covered Doyen forceps placed on jejunum and loop of jejunum next to retracted stomach so that two rubber covered clamps are now adjacent and in such position that proximal limb of jejunum lies next to lesser curvature of stomach and distal limb of jejunum lies next to greater curvature

(35) Proximal limb of jejunum approximated to lesser curvature with one inter rupted suture of silk left long and free

(36) This suture later for retraction and also to diminish tendency toward dis tortion of anastomotic line for it marks an area toward which first line of suture may be placed

(37) Continuous suture of silk inserted from junction of distal loop of jejunum with greater curvature

(38) When possible only serosal and muscular layers of stomach wall and jejunum included in these sutures

(39) Posterior wall of stomach incised throughout extent of stoma down to gastric mucosa

(40) Jejunum incised down to mucosa for distance equal to that decided as suitable for length of stoma and second row of sutures of fine chromic catgut can be inserted Line of suture includes all layers of stomach wall and jejunum and is doubly locked at lesser curvature

(41) Stomach clamp adjacent to one on jejunum then opened to determine whether posterior line of suture has controlled bleeding

(42) Second row of posterior sutures can now be continued anteriorly as locking suture on side which is next to stomach

(43) All coats (but only thin edge of mucous membrane) are included in sutures

(44) Mucous membrane then projects slightly through anastomosis and when clamp on stomach is removed bleeding points may be seen

(45) Continuous mattress suture of silk or fine chromic catgut, can be inserted as

a second row of anteriorly placed sutures to invert protruding edge of mucous membrane

(46) Multiple interrupted mattress sutures of silk inserted to reinforce entire anastomotic line

(47) Anchorage of anastomosis below opening in transverse part of mesocolon This carried out by retracting colon upward and multiple interrupted sutures of silk can then be inserted so that stomach projects approximately 2 cm below this opening

(48) Remaining part of stomach should be in so nearly a normal position as possible in order to reduce hazard of angulation of jejunum at site of anastomosis or immediately distal to it

The Polya Moynihan Operation

(1) A part of the gastrocolic omentum is elevated with forceps

(2) Incision made in bloodless area to expose lesser sac

(3) Margins of opening drawn widely apart to permit easy exploration of posterior wall of stomach and pancreas

(4) Stomach lifted and adhesions to pancreas separated

(5) Omentum then stripped from underlying mesocolon

(6) Middle colic artery identified

(7) Large abdominal swab packed into omental bursa

(8) Right part of great omentum so close to upper border of transverse colon as possible picked up piece by piece and divided between strong ligatures

(9) When separation reaches duodenum care taken not to injure middle colic artery or any of its branches

(10) When lower border of first part of duodenum is reached right gastroepiploic artery ligatured and divided

(11) Stomach and duodenum gently separated from underlying head of pancreas by gauze dissection or division of adhesions

(12) Hand passed under stomach just to right of incisura and finger penetrates gastro hepatic omentum so near liver as possible

(13) Stomach drawn downwards and over to left

(14) Pyloric artery made taut and clamped in two places divided between forceps and ligatured with strong catgut

(15) Upper part of duodenum freed farther from pancreas

(16) Duodenum clamped by two small Payr clamps applied parallelly about three quarters of an inch to one inch away from pylorus

(17) Gauze pack soaked in saline passed beneath duodenum and pyloric part of stomach

(18) Gut divided between clamps with knife

(19) Clamp on gastric side of duodenum covered with gauze squares and drawn well over to left while other clamp is rotated laterally to expose undersurface of duodenum permitting of a little further mobilization of duodenal stump

(20) Duodenal stump then sutured over with right angle continuous stitch drawn tight as clamp is removed Stitch carried back to starting point and securely tied producing purse string effect

(21) Suture line *further reinforced* with a few *interrupted mattress or Lembert* sutures of fine silk or thread, and small pieces of omentum drawn across sutured area and tied into position to give *added protection*

(22) When duodenal stump is very mobile its cut end after being closed in aforementioned *manner may be further* invaginated by purse string suture

(23) As alternative to dividing duodenum between Payr clamps gut may be crushed with Petz instrument and cut across between the two rows of clip sutures Duodenal stump (including its row of Petz clips) is sewn over with continuous Lembert suture and buried, the suture line being further reinforced with interrupted stitches of fine silk

(24) Greater part of left half of gastrocolic omentum now ligatured piece by piece just above transverse colon and left gastroepiploic artery secured and tied with No 2 20 day chromic catgut about middle of greater curvature or preferably a little higher

(25) As ligature of omenta and blood vessels proceeds care taken to keep well *outside zone of involved glands which are left attached to part of stomach about to* be resected

(26) Left gastric artery must next be ligatured near its origin

(27) If stomach is distended it is aspirated by introducing suction tube through stab incision which is made in posterior wall close to pyloric area this incision encircled by purse string suture which is tied so soon as the suction tube is removed

(28) Left gastric artery ligatured near its origin Aneurysm needle threaded with length of No 2 20 day chromic catgut then inserted between border of lesser curvature and artery The artery is trebly ligated and divided between lower ligatures

(29) Distal end of left gastric artery then seized with forceps and together with fatty tissues and glands in remaining part of gastrohepatic omentum is dissected downwards for short distance

(30) Resultant raw surface on lesser curvature peritonized with a number of *closely applied interrupted sutures before proceeding* with further steps

(31) Clamp now placed across whole breadth of stomach from greater to lesser curvature so *high as possible*

(32) Transverse colon lifted out of wound and gently drawn upwards to make mesocolon taut

(33) Fingers of right hand passed along mesocolon toward left of spine

(34) Duodenojejunal flexure identified

(35) First loop of jejunum brought out through wound anterior to transverse colon

(36) Transverse colon replaced in abdominal cavity

(37) Proximal jejunum placed from left to right against stomach and *part* selected for anastomosis picked up with two pairs of Allis forceps and put on stretch this part of jejunum being then embraced by Sherren clamps

(38) Distance between duodenojejunal flexure and proximal part of anastomosis only 4 to 6 inches (usually not more than four inches)

(39) Long roll of gauze placed longitudinally in between and deep to two clamps to prevent contamination of peritoneal cavity by leakage of *gastric or intestinal* contents

(40) Two clamps placed parallel so that the greater curvature of stomach lies against proximal end of clamped jejunum and lesser curvature against distal end

(41) First row of sutures now introduced as a continuous seromuscular suture of fine silk separate stitches being placed close to one another—not more than one eighth of an inch apart

(42) When suture reaches lesser curvature it is locked

(43) Posterior wall of stomach (about one half inch above line of suture) incised from greater to lesser curvature through serous and muscular coats down to mucous membrane

(44) Stomach turned over to right and incision continued on anterior wall

(45) If no undue tension on stomach it may now be sectioned and removed but if there is tension viscus is not removed until posterior through and through suture has been inserted and is about to turn corner at lesser curvature in latter case second *gastric clamp should be applied to stomach about one half inch distal to intended* line of transection

(46) Mucous membrane which bulges through incision in posterior wall of stomach picked up with pair of dissecting forceps and incised from greater to lesser curvature

(47) Jejunum opened along entire length of clamped loop about one half inch above first row of sutures

(48) Contents of gastric and jejunal pouches then removed with small gauze swabs soaked in saline

(49) Inner continuous through and through suture of No 0 or No 00 20 day chromic catgut then introduced It commences at greater curvature picking up all coats of stomach and jejunum and continued completely round anastomotic opening the separate stitches being placed not more than one eighth inch apart When it turns corner of lesser curvature it approximates and inverts anterior margin of stomach and jejunum This inversion is accomplished by drawing suture tight as it emerges from jejunal mucosa slight pressure being applied with thumb and finger on wound just behind stitch

(50) When suture reaches area where it began it is knotted to that part which was left long The first sero muscular suture is then picked up and continued anteriorly as a continuous Lembert suture which invaginates the first suture line A few inter rupted mattress sutures placed here and there wherever suture line appears to re quire additional support

(51) When through and through suture reaches lesser curvature it may continue as running stitch uniting *only* anterior margins of mucous membrane of stomach and jejunum

(52) Anterior sero muscular margins are approximated with continuous stitch which commences at greater curvature and finishes at lesser one The anterior suture line is buried farther by a right angle Cushing stitch

(53) Surgical field carefully examined and especially the anastomosis

(54) Great omentum elevated from abdomen turned upside down and folded so as to cover suture line and prevent it from adhering to anterior abdominal wall

(55) Abdominal wound closed in layers Continuous stitch of double No 1 or No 2 chromic catgut is used for peritoneum interrupted catgut stitches and single con tinuous catgut suture for anterior sheath of rectus muscle while skin margins are

approximated with black silk sutures and Michel clips A few tension sutures of black silk are also occasionally used

POSTERIOR GASTROJEJUNOSTOMY

Von Hacker s Operation

(1) Wide right paramedian incision
(2) Abdomen explored

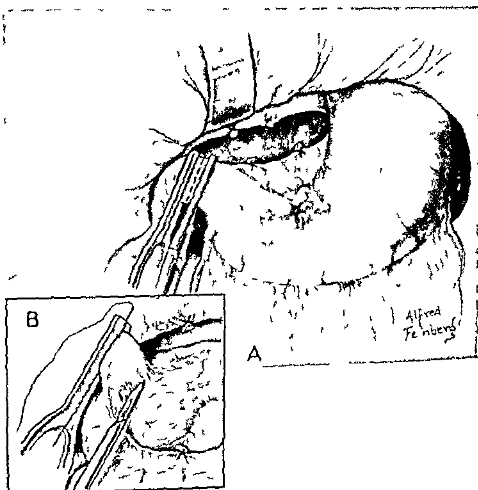


Fig 81 —A Application of Payr clamp on duodenum proximal to Furniss clamp Interrupted line between clamps indicates line of transection B Dissection of adhesions over pancreas

(3) Area selected on stomach close to greater curvature
(4) Greater omentum elevated and brought into view
(5) Transverse colon also brought into view
(6) Expose transverse mesocolon by making traction on transverse colon
(7) Find first loop of jejunum by passing hand along mesocolon toward its base and to left of median line
(8) Find ligament of Treitz to identify duodenojejunal flexure opposite second lumbar vertebra

(9) *If ligament anchors jejunum excessively* (or is short) it can be carefully cut between ligatures while avoiding inferior mesenteric vein

(10) Bring stomach through an opening in mesocolon and gastrocolic omentum

(11) Anastomosis completed in lesser peritoneal cavity

(12) Make opening in avascular area of transverse mesocolon

(13) Avoid injury to middle colic vessels

(14) Bring adequate extent of posterior wall of stomach through opening

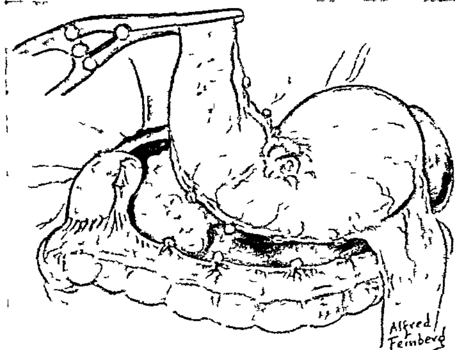


Fig 82—Mobilizing stomach by ligation of gastric and gastroepiploic vessel Gastro-hepatic gastrocolic omenta and great omentum removed

(15) *When division of transverse mesocolon offers difficulty* Moynihan advises following maneuver elevate transverse colon and stomach with left hand making mesocolon taut At avascular area in arch of middle colic artery place artery forceps to undersurface of mesocolon

(16) Mesocolon elevated from posterior surface of stomach and lesser peritoneal cavity opened slightly with scissors contiguous to artery forceps

(17) Opening enlarged lengthwise by gentle separation of edges until it readily admits three fingers Whole posterior surface of stomach can be explored through this opening Longitudinal incision in transverse mesocolon assumes transverse direction when stomach is delivered into wound

(18) Apply stomach clamp diagonally (Mayo s no loop method) in such manner that points of blade are directed toward patient s left side

(19) Loop of jejunum held so that when replaced to normal position its distal part is on lower level than the proximal

(20) Viscera held steady with three blade clamp during manipulation

(21) Lowest area in contemplated opening in stomach selected at greater curvature and parallel to normal direction of first loop of jejunum

(22) Allis forceps temporarily immobilize stomach while single clamps are applied to stomach

(23) About three and a half inches of stomach held in blade end project about an inch or more above clamp

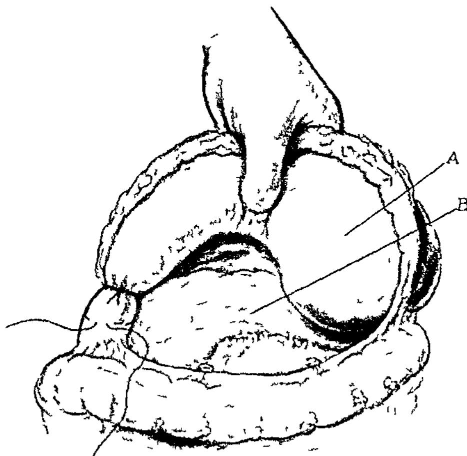


Fig 83 —Another method of closing duodenum without clamps A Stomach B Pancreas

(24) Proximal margin of mesocolon sutured to stomach

(25) Suturing of mesocolon to stomach should be effected *before* anastomosis is made because if it is delayed until after jejunum and stomach are united union of mesocolon to stomach becomes much more difficult and subjects sutures already placed to excessive strain

(26) Margins of rent in mesocolon sutured to stomach with interrupted strands about half an inch above site of purposed stoma (This step prevents subsequent herniation with consequent intestinal obstruction)

(27) If sutured around stomach there may be subsequent constriction *from con*

traction of wound in mesocolon which may cause complications (Moynihan prefers to stitch mesocolon to jejunum rather than to stomach as is usually done)

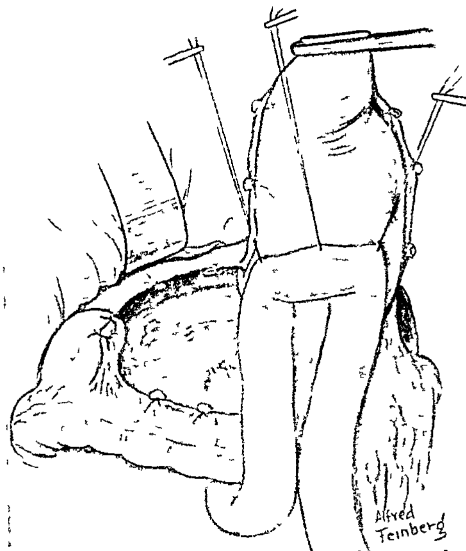


Fig 84 —Tacking jejunum in antiperistaltic manner by three interrupted Lembert sutures These utilized later to anchor first posterior layer (Cushing or Lembert) to prevent puckering

(28) Clamp loop of jejunum of same extent as part of selected stomach area and approximate it to side of stomach in such a manner that its distal end is placed at greater curvature of stomach

(29) Short proximal loop (about two to three inches) or no loop is now used as a rule to avoid vicious circle Whether jejunum is attached to stoma in an iso (Moynihan) or anti peristaltic direction (Mayo) appears to make little difference

(30) Avoid inclusion of mesentery in clamp

(31) Strip jejunum of its contents before applying clamp

(32) Avoid too tight clamping thus obviating possible injury to bowel wall Moynihan's method of applying blade of clamps differs from that of Mayo, the latter suggested application of clamps obliquely while former held stomach in vertical

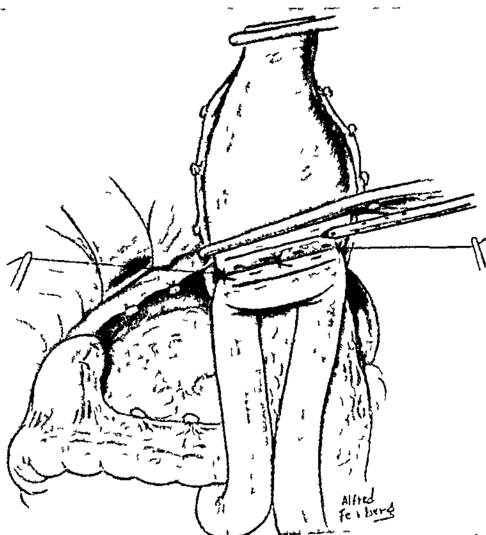


Fig 85 —First posterior sutural layer placed Suction tip inserted into stomach through small opening After aspiration of contents stomach opened as indicated Similar procedure for jejunum

direction in line with vertical part of lesser curvature and ended below at lowest point of greater curvature

(33) Clamp now turned transversely, handle of instrument pointing to left of abdomen and held there by assistant

(34) Jejunum also elevated vertically by another clamp proximal end of which is made so taut as possible before closing blades, this ensures inclusion of jejunum so high as possible toward duodenojejunal flexure

(35) Clamps now placed side by side

(36) Isolate surgical field by laparotomy sponges wrung out of warm salt solution

(37) Laparotomy towel with split center circumscribes surgical field

(38) Place towel over handle of clamps to prevent sutures from catching

(39) First (approximation) suture line is continuous one (seromuscular) which is non penetrating and should include part of submucous coat

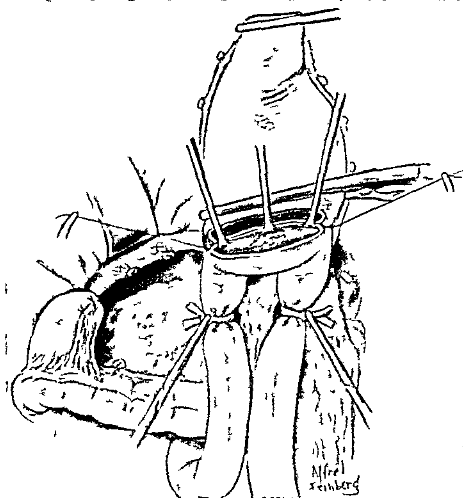


Fig 85 —Umbilical tapes placed by tying only one knot Slipping prevented by applying clamp as indicated

(40) Pagenstecher celloidin linen may be used instead of catgut The suturing is begun as continuous Lembert stitch

(41) Place light forceps on short end of suture and continue it as a Cushing suture sewing parallel to clamps It is locked at opposite end

(42) Another lock stitch can be superimposed on first one at end of suture line for greater security

(43) When placing this suture joining jejunum to stomach suture is gently pulled

upon at each insertion of needle, thus raising ridge which indicates next point of introduction of *needle*

(44) Opening made in stomach and jejunum

(45) *Outline these* openings by lightly scarifying surfaces of respective viscera with scalpel

(46) Incision in stomach is about one quarter of an inch from suture line, a little shorter than its extent and running parallel with it

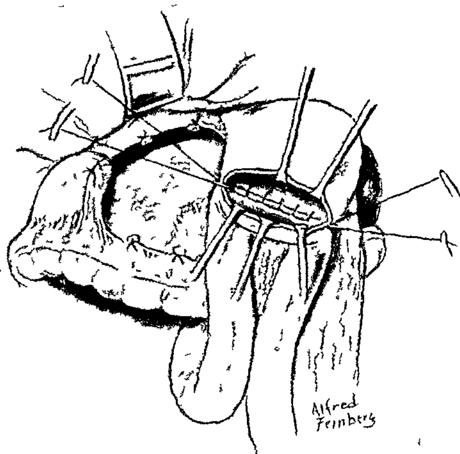


Fig 87—Lock stitches as second layer

(47) Suction apparatus ready (if no clamps are used, Horsley) to empty stomach and jejunum

(48) Carry incision through serosa and muscularis down to submucosa

(49) Larger vessels here now ligated

(50) Elliptic piece of mucosa (not too wide) excised to avoid subsequent contraction

(51) Opening in stomach and jejunum should be about two inches in length

(52) Make stab wound to expel contents of jejunum Open bowel with knife or electro cautery

(53) Swab stoma in stomach and jejunum with iodine on long applicators

(54) Rinse gloved hands or change gloves

(55) Replace soiled covers

(56) Commence second (inner) through and through suturing at lower angle of openings by U stitch as follows pass needle from without into stomach or jejunum midway between knot of first suture and cut edge Penetrate all coats embracing both viscera Needle emerges from opposite side corresponding to point of entrance Tie Apply light forceps to short end of suture as guide Reintroduce needle into jejunum and suture posterior edges of stomach and jejunum with an over and over lock stitch until opposite end is reached Here inner suture is brought outside and tied to first suture Needle is then returned again to lumen and closure of anterior wall is continued with Connell or over and over suture which embraces all coats and is hemostatic The suture line should be firmly drawn When reaching knot

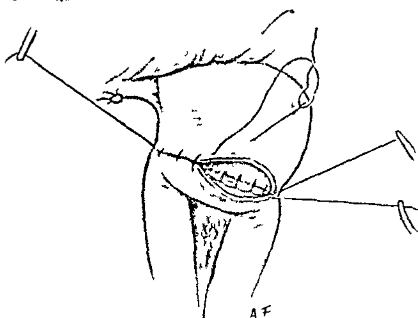


Fig 88—Lock stitch continued as a Connel for anterior wall Note different clamp used for first and second posterior sutures as a mnemonic aid in closure

which marks beginning of second (inner) suture insert one Lembert suture (chromic) just beyond knot and tie it Cut ends of suture short

(57) When second (inner row) suturing is completed release viscera held in clamps and discard soiled linen and instruments

(58) Cleanse field of operation

(59) Wash or change gloves

(60) Inspect suture line for bleeding points picking up long end of outer suture and continue with right angle Cushing stitch to complete operation Tie it to original short end Place a reinforcing stitch at each angle of suture line

(61) Suture distal margin of mesocolon rent to stomach at a distance from line of anastomosis (This prevents herniation into lesser peritoneal sac)

(62) Inspect thoroughly

(63) Replace organs in proper position

(64) Close the abdominal wall in layers

Iason Subtotal Gastrectomy

1 Incision, transverse subcostal

2 Ligation of supplying vessels as in other subtotal *gastrectomies (figs 81 82)*

3 Inversion of *duodenal* stump as in other subtotal gastrectomies (*fig 83)*

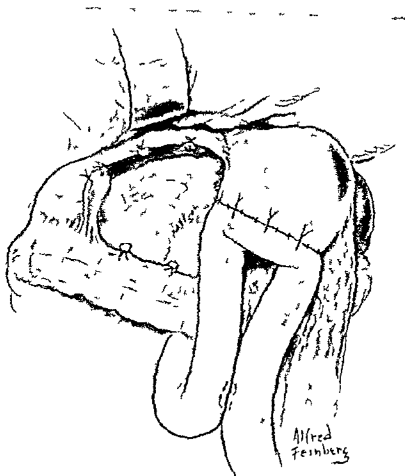


Fig 89 —Closure completed A few additional interrupted sutures may be inserted as indicated Entero enterostomy may be accomplished between afferent and efferent loops as *represented*

4 Stomach mobilized from below upward

5 *Tacking sutures (three or four)* placed to anchor *jejunum to stomach* (fig 84)

6 Cushing sutures then inserted posteriorly and tied *with* each tacking suture (fig 85)

7 Stomach then clamped with Payr instrument as indicated in figure 81

8 Incision made into posterior wall of stomach between this clamp and suture line

9 Contents of stomach aspirated

10 *After aspiration presumably complete Cushing incision in posterior wall of* stomach continued to lesser curvature

11 Umbilical tape placed around afferent and efferent loops of jejunum (fig 86) These tapes knotted once and secured temporarily with clamps

12 Jejunum opened parallel with gastric incision

13 Allis clamps then approximate posterior gastric and jejunal walls

14 Lock stitch of fine catgut to contiguous margins (fig 87)

15 Allis clamps removed consecutively

16 Involved part of stomach then removed by cutting anterior wall of the viscus this margin is then held by Allis clamps Closure of stomach wall then completed by continuation of lock stitch suture in manner of Connell suture First or Cushing

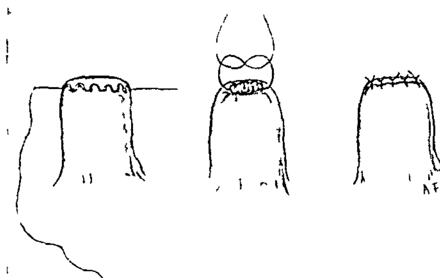


Fig 90 —Closure of duodenal stump after removal of Furniss clamp Interrupted Lembert sutures reenforce original suture inserted through Furniss clamp Stump may be covered with parts of pancreatic capsule and also with contiguous omentum

stitch then continued over preceding suture as a reinforcement A few tacking interrupted sutures may be inserted in Lembert fashion (fig 88)

17 Umbilical tapes applied around jejunum should be removed after Connell suture is completed at which time gowns gloves and drapes are changed (figs 89 90)

18 Abdomen closed in usual manner—chromic peritoneal muscle and aponeurosis

19 Skin closed—black silk

Resection of the Middle and Lower Stomach

(1) High abdominal incision vertical or transverse

(2) Careful inspection of growth and its extensions

(3) If growth is resectable elevate great omentum

(4) Assistant holds colon firmly

(5) Avascular line between the two divided

(6) Great omentum stripped upward off colon and mesocolon and lesser sac thus widely opened

(7) Separation continued to right so far as duodenum and to well above tumor on left

(8) Subpyloric glands lying in area of bifurcation of gastroduodenal artery separated from pancreas

(9) Gastroduodenal artery and vein ligated and divided

(10) Glands remaining attached to stomach freed

(11) Right gastric artery and vein found and tied near origin and peripheral to suprapyloric glands, if it is present

(12) Gastrohepatic omentum divided upward to porta hepatis and then is separated from its connection to liver until it is attached only to lesser curvature

(13) Duodenum now transected at convenient level, but if tumor edge is within 3 cm of pylorus then at least 3 cm of duodenum must be excised

(14) After duodenum is closed stomach is turned up over left side of wound and retractor placed under liver so that left gastric vessels appear

(15) Fine gastropancreatic adhesions separated

(16) Left gastric vein and lymph glands discovered

(17) Lymph glands are separated from right and left suprapancreatic glands and then stripped gently toward stomach

(18) Left gastric vein isolated and divided

(19) Left gastric artery isolated, ligated with silk near origin and then divided between artery forceps and ligated again

(20) Stomach can be lifted well up until esophagus comes into view

(21) Glandular and fatty tissue of lesser curvature now dissected from part of stomach to be retained

(22) Tissue lying to right of esophagus is divided between artery forceps and after ligation upper forceps removed

(23) Lower forceps drawn downwards stripping away all tissue down to muscular coat of lesser curvature, any vessels passing into stomach being ligated with fine silk or catgut

(24) Dissection ended at level of gastric transection and stripped tissues are eventually removed with stomach

(25) On greater curvature gastrocolic omentum will have been separated from colon

(26) Left gastroepiploic vessels and vasa brevia now tied and divided well away from stomach until level of transection of greater curvature is reached

(27) Level of gastric transection should never be below junction of upper quarter and lower three quarters of stomach Transection level should be directly below rather than directly above level of cardiac orifice in doubtful instances

Resection of Middle and Upper Stomach

(1) If upper limit of tumor is so high that transesophageal section is necessary a transthoracic approach is advisable

(2) This approach may be by left abdomino thoracic incision or by posterolateral thoracotomy through low rib space or low (ninth or tenth) rib bed

Lahey Operation

(1) Opening made in transverse mesocolon usually just to left of root of ligament of Treitz

(2) Selection of opening in mesocolon determined by location of middle colic artery

(3) Through this aperture loop of jejunum is passed which is sufficiently long so that when stump of stomach retracts upward into left hypochondrium there will result no undue traction and tension upon area where proximal loop of jejunum is attached to cut end of stomach at area which marks lesser curvature

(4) Proximal loop of jejunum must always be a little longer than at first appears requisite

(5) After completion of posterior Polya anastomosis ligament of Treitz is cut from its lowest insertion into jejunum up to its origin in mesenteric root This permits mobilization of uppermost part of jejunum so that proximal loop of jejunum now anastomosed to stomach can be passed up through slit made in transverse mesocolon In this way entire proximal loop of jejunum is brought above mesocolon and is excluded from greater general peritoneal cavity While true vascular root of transverse colon is still above junction of jejunum with duodenum there is however less angulation of proximal jejunum than when it enters greater peritoneal cavity at jejunal fossa and is again passed upward out of greater peritoneal cavity through a slit in transverse mesocolon It has additional advantage that now only a single segment of bowel (distal jejunal loop) emerges through transverse mesocolon Snug suture of slit in transverse mesocolon about single loop of bowel thus possible and danger of hernia through this slit lessened (figs 91 92)

Finsterer's Operation

(1) Abdomen exposed through midline incision

(2) Abdomen explored

(3) First step consists in freeing great omentum from transverse colon this is accomplished by holding omentum and colon apart and running knife along avascular plane between them close to wall of colon (Alternatively scissors may be used to snip tissues close to gut to effect this separation)

(4) The old plane of physiologic adhesion being opened up it is a simple matter to separate it down to the posterior abdominal wall with a gauze swab when the fetal condition is re established above the postmesogastrium with the omentum below the transverse mesocolon and colon If the correct watershed is opened there are no bleeding points The only ligatures required are at the two ends of the gastroepiploic arch, one at the origin of the right vessel from the gastroduodenal and the other near the spleen [164]

(5) After left and right gastroepiploic arteries have been tied near their origin blood vessels which constitute pyloric artery isolated ligatured and divided close to upper border of pylorus and duodenum

(6) Pylorus and first part of duodenum carefully mobilized and numerous anomalous blood vessels springing from head of pancreas separately ligatured

(7) Duodenum then divided and its distal end closed at an area three quarters of an inch beyond pylorus This may be effected by one of the following three methods

(a) Use a Friedrich Petz clamp whereby gut is severed through crushed groove

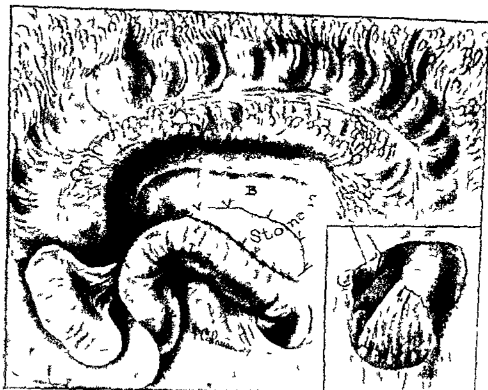


Fig 91 —Polya operation with transmesocolic gastrojejunostomy A Transverse colon B Transverse mesocolon

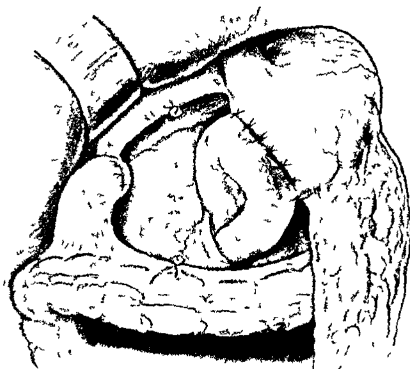


Fig 92 —Transmesocolic antiperistaltic subtotal gastrectomy

between two rows of clips and distal end invaginated with series of closely applied Lembert sutures

(b) Crushing of intestine with enterotribe tying a stout ligature around groove and after dividing intestine invaginate distal closed end of duodenum with two purse string sutures

(c) Divide duodenum between two Payr clamps and effect duodenal occlusion by suturing over clamp with a right angle continuous suture which is drawn tight as clamp is removed

(8) Gastro hepatic omentum then divided so close to liver as possible and left gastric artery tied

Ogilvie[184] wrote

> The left gastric is not only the main source of supply of the lesser curve but it anchors the upper part of the stomach to the posterior abdominal wall and it is surrounded by the lymphatic gland which drain this part Ligature of this vessel near its origin is essential to cancer surgery because only after such ligature is it possible to clear the lymphatics right up to the esophageal opening in one piece with the stomach High ligature is necessary on ground of function as well because after a Polya gastrectomy the remainder of the stomach must be free to lie in a new plane and move in a fresh axis The normal stomach is slung like a hammock between its two openings the left gastric artery springs from the center of this arc and is never pulled upon The resected stomach hangs like a pendulum vertically from the esophagus and the peritoneal ligament are until the esophageal opening If the left gastric artery retains any attachments with the lesser curve it becomes an anchor limiting movements A good many patients with post surgical discomfort are I believe referable to such fixation
>
> The stomach is thrown upward towards the left shoulder of the patient the main artery is put on the stretch a ligature can be passed around it slid down and tied close to the coeliac axis After such proximal ligature the gland and fatty tissue can be cut away in operations for cancer right up to the cardiac orifice and stripped downward leaving the lesser curve bare to the point of intended section

(9) Stomach now free and movable attached only to esophagus and gastrosplenic omentum and is ready for application of Petz clamp

(10) Clamp applied obliquely from an area on lesser curvature directly below esophagus across body of stomach to an area on greater curvature some two inches or so below where left gastroepiploic artery was tied

(11) Petz clamp closed and clips introduced

(12) Stomach then divided by electric cautery between row of clips and resected part together *with its attached omenta and glands* removed in one piece

(13) Right or upper half of cut surface of stomach is then closed by two or more rows of interrupted Lembert sutures infolded line reaching almost to esophagus

(14) Anastomosis of lower half of stomach to proximal jejunum carried out as follows opening is made in mesocolon well to left of middle colic artery (which must be avoided), and through mesocolon a fairly long loop of proximal jejunum is drawn into supra-colic compartment Left hand side opening in mesocolon is sewn to posterior surface of stomach *before* anastomosis is started right hand leaf is sutured to anterior wall of stomach *after* anastomosis is completed

(15) Anastomosis in its entirety now in the infra-colic compartment

(16) Part of jejunum selected for anastomosis should be some six to eight inches from duodenojejunal flexure This loop clamped and after anastomosis is completed

proximal jejunum is then stitched to closed (upper) part of stomach reinforcing suture line and interposing thick valve of gastric and jejunal wall between cut stomach and proximal loop

(17) Jejunum now lies almost vertical and its *efferent limb runs downwards in* direct continuation with mouth of funnel shaped stomach

It is advisable to leave a corrugated rubber drain through a convenient part of the laparotomy incision after incomplete gastrectomy This is particularly *true after* difficult operations which have involved the pancreas and it is wise to retain a shortened piece of corrugated rubber through the abdominal *wall for ten or even twelve* days *The reason for this* is that late leaks occur and if there is a drain in place gastric *or duodenal contents find their* way to the surface

Contraindications to Gastrectomy

(1) Age—as a rule in patients over 75 years of age

(2) If pulse and temperature are up as this indicates low grade mediastinal involvement or infection

(3) Metastases in the liver or glands

(4) *Persistent diarrhea which may indicate direct spread of the lesion*

Lymphatic Spread

It should be recalled that some of the lymphatic vessels from the stomach drain *into glands which are unconnected with the stomach*

The lymphatic vessels of the viscus intercommunicate freely and there is free communication with the vessels of the esophagus

The vessels from the lesser curvature of the stomach pass towards the glands grouped around the descending branch of the left gastric artery and to those around its main stem *From the area of the cardia vessels pass to the paracardial* glands which surround the cardia and even some pyloric glands may pass to this group The vessels from the upper part of the great curve of the stomach pass to the glands in the gastrosplenic omentum in the splenic hilum and adjacent to the pancreatic tail Glands from the right half of the greater curve and some of the pyloric area pass to the glands round the right gastro epiploic vessels *and to the subpyloric* glands A few vessels from above the pylorus may enter a suprapyloric gland or biliary chain of glands

From these glands the further drainage is as follows the glands round the stem of the left gastric artery and also the paracardial glands continue into those round the celiac artery—the *middle suprapancreatic* group The splenic group of glands drain into those around the splenic artery (the left suprapancreatic glands) and thence to the celiac group The right gastroepiploic glands drain into *the subpyloric glands* and from the latter many vessels pass direct to the superior mesenteric glands (This explains the frequency with which these glands are involved in cancer of the *pyloric end of the stomach*) Others pass upwards to the celiac group of glands Occasionally the vessels course from the suprapyloric glands to the glands around the main stem of the hepatic artery as it lies above the pancreas—*the right suprapancreatic group* of glands

Some Dangers and Complications of Gastrojejunostomy

These are

(a) Hemorrhage
(b) Infection
(c) Vicious circle vomiting
(d) Stoma ulcer (sometimes fistulous into colon)
(e) Contraction of opening
(f) Intestinal obstruction
(g) Diarrhea

PALLIATIVE OPERATIONS

Gastrostomy The best palliative surgery is perhaps simple removal of the growth If this is found to be impossible by reason of its extension into adjacent or contiguous organs it has been debated whether any alternative is of value

Exclusion of the growth, devised by Devine it is maintained gives greater relief than gastrojejunostomy and is associated with a mortality which is not higher In the majority of examples it prevents the patient at least from dying of obstruction

The object of all gastrostomy operations is the establishment of a fistulous tract between the stomach and skin surface so that the patient can receive alimentation

The ideal gastrostomy should

(1) Be lined with mucous membrane (Depage and Janeway operation)
(2) Not permit leakage of gastric juice and ingesta (Fontan operation)
(3) Obviate the use of a catheter between feedings
(4) Facilitate introduction of a tube for feeding and retrograde esophagoscopy gastroscopy, retrograde bouginage and radium therapy

Witzel s Operation This operation is accomplished where the stomach is so small and tubular that it is difficult or even impossible to raise a cone from the anterior wall

A No 12 or 14 rubber catheter is introduced for two to three inches into the interior of the stomach through a small puncture made in the anterior wall midway between the greater and lesser omentum The tube is anchored to the incision by a single catgut stitch or purse string suture which passes through and immobilizes the tube

The catheter is then laid *on* the stomach for two inches and pressed firmly into its surface so that it lies in a formed groove The groove is then converted into a tunnel by the introduction of a series of interrupted Lembert sutures two or three interrupted sutures being passed beyond the opening of the viscus to forestall leakage The tube therefore rests in a serous lined tunnel A valvular effect is thus obtained

A small stab wound is next made one inch or so lateral to the first abdominal incision and through this the gastrostomy tube is drawn The surrounding stomach wall is carefully anchored to the peritoneum and posterior sheath of the rectus muscle

The abdominal incision is closed

Modification of Witzel s Technic An incision one and one half inches in extent is made through the seromuscular coat on the anterior wall of the body of the stomach about midway between the curvatures down to but not through the mucous membrane At the lower end of this incision the mucous membrane is perforated and a catheter is introduced into the cavity of the stomach for two to three inches The

catheter, being fixed to the margin of the small opening by a catgut stitch is then made to lie in a tunnel by suturing the edges of the sero muscular incision with a series of interrupted Lembert sutures

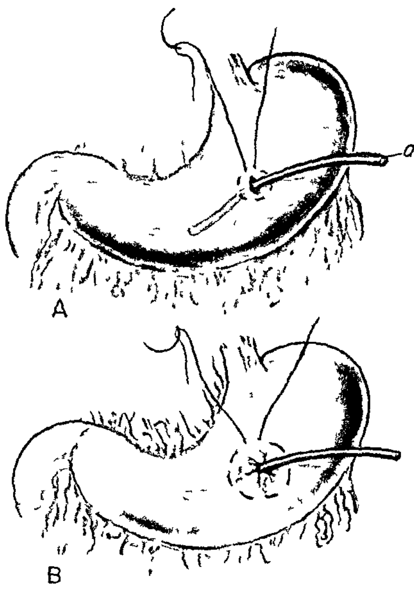


Fig 93 —Kader gastrostomy A Abdomen opened through high left upper abdominal incision of any variety Purse string suture is placed Stomach opened in center of suture and No 26 catheter (a) inserted into gastric lumen Suture tied and cathether then transfixed B Second concentric purse string suture then inserted and tied

Ssabanejew Frank Albert Kocher Gastrostomy This operation consists of delivering a cone of stomach through a high upper left rectus incision and passing it through a subcutaneous tunnel The apex of the cone is brought out through a short incision just above the left costal arch to the edge of which the open cone is fastened after closing the primary incision below it

Kader's Operation The stomach is brought through the abdominal incision and a catheter or rubber tube is introduced into the stomach. Two vertical and parallel seromuscular folds of the anterior wall of the stomach are then drawn together above and below the tube, by the introduction of a few Lembert sutures. The suture line is further invaginated by the introduction of another series of sutures which elevate the stomach wall on both sides of the original line of sutures. The gastrostomy tube is thus buried by a two fold pleat of the stomach wall and a *cube* instead of a cone is made to project into the cavity of the viscus (figs 93, 94).

Gastroenterostomy This procedure is sometimes utilized as a palliative measure in obstructive inoperable lesions (fig 95).

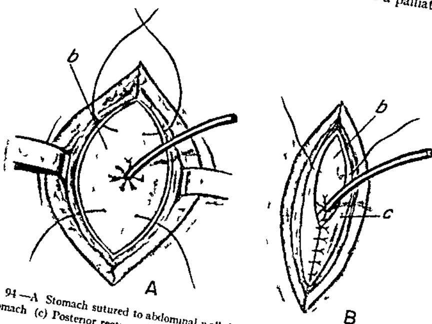


Fig 94.—A Stomach sutured to abdominal wall. B Abdominal wall closed about catheter. (b) Stomach. (c) Posterior rectus sheath.

Lepage Janeway Operation This operation is indicated where a *permanent* gastrocutaneous fistula is required for feeding purposes. It is accomplished in the following manner:

(1) Left paramedian or a left transrectus or muscle split incision commencing at costal margin and proceeding downwards for about two inches (figs 96–98).

(2) A large cone of anterior wall of stomach high up so near to the fundus as possible is drawn through wound which is carefully protected and packed off with gauze swabs.

(3) A flap of anterior wall of stomach, two inches by one inch, with its long axis stretching from greater to lesser curvature and with its base on greater curvature is delimited by picking up the surface of the stomach with four pairs of Allis forceps. Two pairs of these forceps mark free upper end of flap and are placed about one inch apart while forceps (which indicate base of flap) are about one and one quarter inches apart.

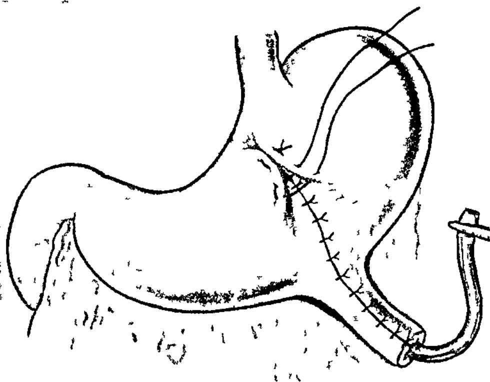


Fig 97 —A reenforcing layer of interrupted Lembert sutures is inserted from lesser curvature to tip of tube Fine black silk or cotton may be used

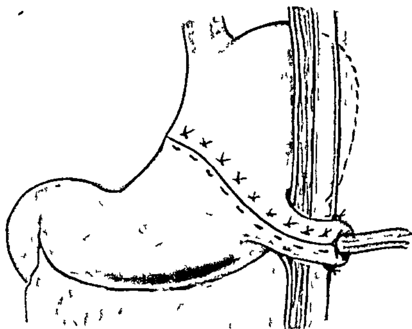


Fig 98 —The tube is brought out through a stab wound or counter incision or through the original abdominal incision about 1½ cm beyond skin edge and transfixed to skin margin with fine silk sutures

(19) Three ounces of peptonized milk are given three hourly through tube and increased until patient is receiving 8 to 10 ounces every four hours

(20) During first three or four postsurgical days rectal or intravenous saline is given to combat dehydration

(21) Tube removed on eighth day and inserted again only when required for feeding purposes

Stamm s Operation

(1) Small incision over upper and outer third of left rectus muscle commencing at costal margin and passing vertically downwards

(2) Margins of peritoneum cut and posterior sheath of rectus picked up and drawn apart

(3) Colon drawn downwards and upper part of stomach coming into view is delivered through wound

(4) Site for gastrostomy selected on anterior wall of body of viscus high up and so far removed as possible from pylorus

(5) Wound carefully packed off with gauze

(6) Area midway between greater and lesser curvature on anterior wall of body of stomach selected for insertion of tube

(7) Site marked by two pairs of Allis forceps which seize stomach and lift it upwards

(8) Small opening sufficiently large to admit a No 12 or No 14 catheter made between Allis forceps on anterior wall of stomach either with knife or electric cautery

(9) Rubber tube inserted into stomach cavity for two–three inches and attached to margins of wound by catgut stitch which picks up all coats of stomach and a part of tube

(10) Sero muscular purse string suture introduced half an inch away from tube and as it is tightened tube is pushed into cavity of stomach suture being tied firmly enough to grip without compressing tube

(11) Second and third purse string suture similarly inserted and margins around tube further invaginated with result that cone shaped part of stomach projects into cavity of organ embracing tube

(12) When last purse string suture has been tied stomach anchored to peritoneum and posterior sheath of rectus muscle

(13) Abdominal wound closed with interrupted sutures gastrostomy tube being made to project through lower end of incision

(14) Tube plugged with spigot and fastened to skin by an encircling stitch which prevents it from being accidentally withdrawn

(15) Fluid nourishment introduced through tube every two hours during day and once or twice during night It is best to begin with small frequent feeds and gradually increase *small amount until patient receives adequate feeds at long intervals* At first only two or three ounces can be given at a time but later stomach will be found to tolerate so much as 5–10 ounces Fluids most frequently used for feedings consist of citrated milk concentrated glucose solution beef tea eggs and orange juice

(16) Tube works loose in 10–14 days and should be removed sterilized by boiling and replaced

(17) Before patient is discharged he should be instructed how to remove and reinsert tube, clean it, and feed himself through it

Some Complications of Gastrostomy

(a) Aspiration pneumonia
(b) Venous stasis around tube
(c) Dropping out of tube
(d) Injuries to omentum
(e) Infections
(f) Leak of gastric juice through stitch holes in suture line of stomach or tube, causing peritonitis
(g) Marginal necrosis
(h) Formation of "dead" spaces
(i) Cutting out of sutures (Marwedel)
(j) Prolapse of mucous membrane of stomach
(k) Acute dilatation of stomach
(l) Persistent vomiting
(m) Collection of food particles between tube and stomach, causing infection
(n) Contamination of fistulous tract
(o) Prolapse of stomach

Indications for Jejunostomy

(a) Alternative procedure to gastrostomy
(b) Where invasion of stomach wall and growth is so extensive that gastrojejunostomy or gastrostomy is inadvisable
(c) For irremovable malignant hour glass stomach
(d) Where there is obstruction of the duodenojejunal flexure or proximal jejunum owing either to direct spread of growth from stomach or to malignant glands at root of mesentery
(e) In patients desperately sick

CHAPTER XI

Postsurgical Treatment

The details of postsurgical treatment vary obviously depending upon the relative importance of the various signs symptoms and sequelae

The care may be considered completed when the patient is readjusted to everyday life—usually in six months to a year

In the immediate postsurgical care it is important that the unconscious or partly conscious patient is not exposed to cold nor carelessly handled

The problem of return of the shocked patient to his room is best solved by bringing the bed to the operating room and transferring him gently from the table to a well warmed bed

It is now best to elevate him so soon as it is safe Peritoneal exudates then tend to gravitate towards the pelvis and away from the subphrenic space further sub diaphragmatic pressure is relieved and embarrassment to respiration is thus greatly diminished

Patients who have had a spinal analgesia must remain flat for at least six hours and preferably a little longer in order to reduce the tendency to subsequent severe headache

Every point in the hematocrit reading above 45 or two points above 95 in the hemoglobinometer reading indicates the loss of 100 cc of plasma The treatment of shock is the giving of plasma and also if necessary saline intravenously

It is well to recall that shock may be hematogenic neurogenic and vasogenic and that the patient should be treated accordingly The first category is characterized by great loss of blood the second by reflex loss of vasomotor tone and the third by dilatation of blood vessels occasioned by action of toxins on their walls

Secondary shock may be attributable to loss of whole blood plasma water and electrolytes or any conjunction of the three Whole blood plasma and isotonic saline solution are the means of replacement

Use of oxygen The patient should be informed that the use of oxygen is in con templation

Five per cent carbon dioxide and 95 per cent oxygen are administered every hour for approximately three minutes for the first day or two

(For an adequate supply of oxygen the alveolar concentration must be 50 per cent or more)

Oxygen is best given by intranasal insufflation through an inlying fine nasal catheter supported by a headband or spectacle frame Flow of 6 to 8 liters is maintained If an oxygen flow in excess of 6 liters is used the gas must be bubbled through water so as to maintain adequate humidity and thus avoid dryness of the mouth and throat

Use of Sedatives Only minimal amounts of sedatives, narcotics and analgesics should be used During the first 36 postsurgical hours 50 to 100 mg of demerol hydrochloride is often sufficient (Opiates should be avoided) Prostigmine often proves effective in relieving pain For intractable pain paravertebral block with Efocaine is of benefit

Aspiration of Bronchial Mucus The treatment for excessive bronchial secretions which often prevent adequate pulmonary ventilation, or produce atelectasis and which favor infection, is the first problem which arises as a rule, after major thoracic surgery The patient fears to cough but should be encouraged to do so The removal of secretions is assisted by 'postural coughing, that is coughing while lying on one side or the other with the foot of the bed raised and the head low without pillows Strong doses of ammonium carbonate and coramine are also helpful in this regard

Some lethargic or ill patients do not easily expel their bronchial secretions It is advisable then to pass a No 16 French rubber catheter blindly through the nose into the trachea and bronchi and aspirate the secretions

Two methods are used in the removal of tracheobronchial secretions An endotracheal tube may be passed, under topical analgesia by visible or blind technic and through this tube a suction catheter is passed Daily roentgen and clinical observations serve as a guide to the bronchi needing aspiration Where the endotracheal tube has not produced satisfactory removal of secretions bronchoscopy is carried out

Aspiration of Stomach and Esophagus It is important to keep the stomach deflated in the first four or five postsurgical days to prevent this organ from becoming distended and causing tension on the suture line as well as compression of the lungs It also permits easy postsurgical feeding through the distal lumen

Two important postsurgical problems are (a) adequate intra gastric drainage and decompression to prevent pressure at the line of anastomosis, (b) nutritional requirements until the patient can take adequate food by mouth

Most surgeons are in agreement concerning the routine aspiration of the stomach, morning and evening the first few days after the operation This procedure prevents great accumulation of fluid and gas in the stomach which by traction on the gastric muscles further reduces tonus and peristalsis of the organ Vomiting with the consequent possibility of aspiration into the respiratory tract is thus avoided

Again, regular emptying of the stomach also prevents too great development of bacterial growth therein, especially of the common species of colon bacilli

The position of the patient in the post surgical period is also of importance in gastric evacuation In the supine position the gastric content collects in the cardiac area and therefore not at the site of anastomosis It is of importance therefore that the patient maintains a position so nearly erect as possible and also that he is allowed early ambulation in order that the effect of gravity on gastric contents may assist the reduced peristalsis

A Levine tube with a Wangensteen suction apparatus attached, provides adequate drainage

A simplified suction feeding tube (devised by Singmaster of Philadelphia) consists of an 18 French double lumen tube of soft rubber sealing a column of mercury within for a distance of three inches from the tip Directly proximal to the sealed mercury

column are perforations for feeding purposes Thirteen inches proximal to the tip is another series of perforations for intragastric suction The proximal end of the tube has a double lumen metal connection one lumen of which is marked F for feeding and the other "Suction" The feeding lumen terminates in the perforations at the end of the tube and is completely separate from the other lumen which ends in perforations well proximal to the tip The tube is so divided that the suction lumen is of larger diameter than the feeding lumen allowing adequate drainage of blood and gastric secretions post surgically The feeding lumen is adequate for liquid protein preparations in proper dilution

When Ryle s tube is used it is best left in for twenty four hours after surgery It should always be passed when there is a rise in pulse rate distension in the upper abdomen, if the patient has nausea or if he complains of any increasing pain or distress

Twice daily aspiration of gastric secretions is done by means of a small calibre intranasal tube until the amount of secretion aspirated has decreased to less than 100 cubic centimeters If more than 500 or 600 cc is obtained nasal suction is usually indicated

The aspiration prevents the anastomosis from rotating and thus becoming obstructed The tube may also be used to give continuous albumen water drip early in the postsurgical period The tube may be left in up to 48 hours but should be removed if it distresses the patient

If gastric retention is persistent a jejunostomy is necessary On rare occasions the gastro enteric stomach retracts through the opening in the transverse part of the mesocolon causing variable obstruction to the distal loop of jejunum A jejunojejunostomy is then necessary between a loop proximal to the site of anastomosis and a loop distal to this area

The transnasal gastric tube is used as a means of obviating vomiting of emptying and irrigating a dilated stomach and of keeping the viscus empty An adequate fluid intake measured and recorded can also be ensured

After sterilization the tube is tested for patency and integrity by syringing water through it It is lubricated with sterile liquid paraffin

The nostril is cleansed and the bulbous end of the tube is passed along the floor of the nose The patient is instructed to swallow

If an unconscious patient requires nasal intubation he must be held in a sitting position leaning somewhat forwards The mouth is opened and a mouth gag inserted The tube is passed through the nose in the usual manner until the tip is felt in the pharynx Two fingers are used to push the tip of the tube into the mouth and onwards past the epiglottis

A tube passing through the nose can remain in place for days without causing perceptible rhinitis but only if reasonable care is given in the prevention of infection

Once the tube is in place satisfactorily it can be strapped to the cheek with adhesive plaster When the tube has to be used as a means of gravitating fluid into the stomach it is strapped to the forehead near the midline

When vomiting is persistent the stomach content is watery and it therefore can be readily aspirated

As a rule the gastric aspiration tube is not left in place more than forty eight hours After this time it is advisable to remove and boil it after which it can be replaced, if necessary, preferably through the contralateral nostril

After the stomach has been resected and before beginning the insertion of the anterior row of sutures for the anastomosis between the stomach and jejunum the tube is removed from the fundus and passed into the efferent loop of the jejunum The tube is sutured *in* place by using No 1 plain catgut which also passes through the tube and the posterior line of anastomosis (The catgut is absorbed in 24 to 48 hours)

Immediately on return from surgery the tube in the stomach is connected with the suction apparatus and into the one in the jejunum The drip is then started The drip solution consists of 800 cc normal saline and 10 per cent glucose, 200 cc of 15 per cent amino acids, 100 mg ascorbic acid, 20 mg thiamine hydrochloride 5 mg riboflavin and 50 mg nicotinic acid The solution is dripped in at the rate of 40 drops per minute, this will insure the introduction of approximately 1000 cc every eight hours Water is used alternatively instead of normal saline

The tube is usually left in place for 72 hours

Hydration In the postsurgical period the patient may have need for any one of the following (a) cells, (b) electrolytes, (c) water, (d) plasma, (e) adjustment of acid base balance, (f) caloric intake to maintain metabolism, (g) vitamins

On the score of fluid and electrolyte administration there is a growing awareness that many patients have been over watered" and "over salted " This found corroboration in the work of F A Coller *et al* [109] on the condition of the kidneys following operation

Whatever the cause of the loss of fluid it is important that it should be made good without delay

The following points should be considered (1) intake and output of fluids, (2) measurement of abnormal losses of secretions such as vomitus drainage from intubation or fistula (sweating may produce an error), (3) initial and final body weight, (4) general state of the patient and evidences of peripheral circulatory collapse (hypotension, hemoconcentration, oliguria or anuria azotemia) In general *blood studies* of the sodium and chloride content the blood volume blood viscosity carbon dioxide combining power and non protein nitrogen, as well as the red cell count and hematocrit values offer limited information concerning the state of water balance

The urinary output remains a reliable guide of adequate hydration A patient having continuous gastric suction usually requires about *3000 cc intravenously every* twenty four hours This is given as 2000 cc of 5 per cent dextrose and *1000 cc of* 5 per cent dextrose in physiologic saline solution

Patients requiring infusions but not losing gastric juice can be given 1000 cc of saline solution every second day

During continuous gastric suction the patient requires about *3000 cc of saline* every 24 hours A useful rule particularly with the aid of intake output charts is to add 1000 cc of fluid (insensible loss) to the amount of output from all orifices (e g suction drainage urine) If at any *time it is necessary to administer three or* more liters of fluid a day intravenously it is well to give *two liters in the morning* remove the needle and give the remainder in the late afternoon or *evening*

Scudder[170, 171] described a method for control of fluid therapy which has the merits of accuracy and simplicity. The specific gravity of whole blood and of plasma is determined and a hematocrit reading is obtained before or after surgical procedures in patients who are seriously ill and in patients who are to undergo such procedures as resection of the stomach or bowel. As previously stressed by carrying out pre surgical studies it is frequently possible to choose the optimal time for operation.

Parenteral fluids are continued until intestinal movements can be heard usually forty-eight hours after operation when they are replaced by a normal intake of fluids by mouth.

Nutrition The means other than the oral route adopted to meet the patient's nutritional requirements are the following

(a) *Rectal Feeding or Drip Enema* *In this way the patient can receive 1500 to* 2000 ml saline solution and 5 per cent glucose during a twenty four hour period. This method has some disadvantages. Some patients are greatly annoyed or distressed by the enemas; others find it difficult to retain them and no definite information is obtainable of the quantities of fluid actually retained by the patient.

(b) Subcutaneous Feeding The fluid is usually introduced subpectorally or on the lateral aspect of the thighs.

(c) Intravenous Feeding The patient may be given saline solution, Ringer's fluid or 5 per cent glucose in parts of 1000-1500 ml once or several times daily. The fluid should not be infused too rapidly. If large quantities of fluid are required they are given as a "permanent" drip.

Pack[158] states

> Some surgeons institute early feeding following esophageal surgery and there has been no definite evidence that this practice is dangerous. It would seem advisable therefore to start using a high protein and high carbohydrate fluid diet by mouth within one or two days of operation.

Metabolic disorders after subtotal gastrectomy are rarely of a severe order. Steatorrhea may occur but can usually be controlled by a reduction in the intake of fat and is not owing to any great failure of the pancreas.

At times acute edema around the anastomosis between the gastric stump and the jejunum does not permit anything to pass for a few days. This condition commonly recedes and a secondary operation is seldom necessary. However if the condition persists immediate distress and vomiting follow attempts to feed the patient. To obviate dilatation of the stump an indwelling stomach tube (Wangensteen apparatus) is placed so as to constantly siphon excess fluids. If the suction tube is clamped off part of the time the improvement in the drainage through the stoma may be detected provided the intake and drainage quantities are measured.

There are some other mechanical factors. For example a great reduction in size of the stomach with a corresponding diminution in storage capacity. For this reason many patients for a considerable time after operation experience difficulty in taking adequate amounts of food. This condition tends to correct itself in a few weeks or months. Five or six meal a day schedule is often advisable until the capacity of the gastric stump increases.

Patients with esophago gastric or jejunal anastomoses must drink no fluids for 48 hours and to them intravenous plasma and/or saline must always be given during

the first two days, the amount given and the duration depending on the patient's condition

(If little or no retention is present the patient may receive fluid orally forty eight hours after operation Clear fluids in amounts of one ounce per hour may be allowed and if well tolerated the amount may be increased to two fluid ounces per hour later in the day)

On the first day the patient is given repeated drinks of sterile water—one ounce hourly, and drip saline per rectum He is permitted to drink so much as he wants of water, weak tea, or barley water sweetened with glucose but not more than two ounces at any one time

The second or third days citrated milk and water (equal parts) one ounce hourly, and plenty of water and albumin water, two ounces at a time or alternate hourly feedings of citrated milk, one and a half ounces and citrated milk one half ounce added to one ounce of albumin water

The fourth or fifth days, egg flip with milk, three ounces four hourly, milk in between, three ounces and water as required, are given Or citrated milk two ounces into each pint of which is beaten up an egg Two ounces of water are given between each hourly feed or three ounce feeds of egg and milk every one and a half hours, water, as before—one ounce sipped between each feed

The sixth and seventh days the diet is gradually increased jellies, custards and drinks as desired by the patient The sixth day four ounce feeds may be given every one and a half hours milk egg and milk or flavored feeds as desired Water is now given more freely and junket is added to the mid day and 6 p m feeds The seventh day two hourly feeds of five ounces with egg custard added to midday and 6 p m feeds

The eighth day full ulcer diet only soft solids and liquids small quantities at first increasing to normal by the twelfth day when 2000 calories should be reached Or thin crustless bread and butter and milk pudding added A lightly poached egg and thin bread and butter should be substituted for the 6 p m milk feed

Ninth day add creamed potatoes and weak milky tea

Tenth day breakfast lightly boiled egg bread and butter and milky tea Dinner, pounded fish creamed potatoes, egg custard or jelly Afternoon milk or flavored milk is given between meals

Fifteenth day full diet with semi solid food and no fried or roasted meat

Eighteenth day full diet

Vitamin Supplements At least twice the average requirement of all vitamins should be given parenterally Thiamine should be given—20 to 40 mg a day, riboflavin—20 to 40 mg a day ascorbic acid 500 to 1000 mg vitamin A 15 000 U, vitamin D 1500 U daily, nicotinic acid 250 mg, calcium pentothenate, 50 milligrams

Another regimen is carried out as follows:

First and second post surgical days nothing by mouth

Third day one ounce of water per hour

Fourth day add one ounce of strained gruel or malted milk made with water

Fifth day increase gruel or malted milk to two ounces per hour

Sixth day increase gruel or malted milk to three ounces per hour

Seventh day, water as desired The gruel or malted milk feedings may be varied with diluted fruit juice plain milk broth or soup Add one feeding of soft solid food

Eighth ninth tenth eleventh and twelfth thirteenth and fourteenth days continue hourly fluid and add progressively each day an additional feeding of soft solid food until the patient is receiving a small quantity (not over six ounces) of soft food every two hours

Fifteenth day until discharge five or six small meal schedule from a general convalescence diet except that salads and raw fruits are avoided and the cooked vegetables are pureed Meat particularly liver is allowed in liberal proportions

During convalescence the diets may be as follows Clear liquid one broth coffee strained fruit juice peppermint tea postum tea Vichy water ginger ale

Liquid Diet Albumens barley water buttermilk cocoa clear fruit gelatin fruit juices plain ice cream Junket malted milk milk strained milk soups orangeade, oyster broth sherbert gruels (thin, strained) water ices grape juice tomato juice, raw vegetable juices

Bland Diet Soft semi solid cereals (refined) cornstarch pudding cooked fruit pulp cottage cheese eggs (cooked in shell creamed or poached) fruit whip or souffle milk toast, rice (well cooked) sago soups (strain coarse vegetables) tapioca

Light Diet (diet under semi solid plus) bacon baked or broiled fish baked potato bread cooked fruit raw fruit except apples creamed sweetbreads creamed vegetables asparagus watercress celery endive lettuce tomato spinach green cooked vegetables except cabbage cauliflower onions mashed potatoes spaghetti scraped beef white meat of chicken or turkey

Dr Colp s post surgical dietary regimen at the Mt Sinai Hospital (N Y C) is as follows

Day of operation	Dram 1 water q i h Levine tube into bottle Aspirate q i h Water at night only if awake
First Day P O	Oz 1 fluid q i h (tea water) Fluids at night only if awake
Second P O Day	Oz II (2) liquid q i h (tea water or milk) Liquids at night only if awake
Third P O Day	Feeding q 2 h 1 tablespoonful jello custard or junket and water broth tea or milk up to 3 ounces Feedings at night only if awake
Fourth P O Day	Feedings q 2 h 1 tablespoonful jello junket custard eggnog thin gruel thin farina and any liquid up to 3 oz Therapeutic vitamin capsule B I D *Feedings should not be forced* *No night feedings on fourth day*
Fifth P O Day	Feedings q 2 h Strained vegetables Milk toast small feedings

Sixth P O Day All above plus scraped beef, minced chicken until 9th day
No food after 7 p m No fluids after midnight
Pass Levine tube and aspirate Chart amount and save specimen
Give 200 cc of strained oatmeal gruel Take specimen q 15 min for two hours
Test a small portion of each specimen with Topfer's solution until one turns red and shows the presence of acid Do not put the Topfer s into the specimen tube
If no free acid is obtained after one and one half hours give 0 5 mgm of histamine by hypodermic injection and collect specimens for an additional hour

Muelengracht Diet

7 30 a m	Tea white bread butter
10 a m	Oatmeal with milk, white bread and butter
12 30 p m	Meat balls, broiled chop omelet fish ball vegetable gratin or fish gratin mashed potato vegetable puree and soups stewed apricots applesauce, gruel or rice tapioca pudding
3 p m	Cocoa
6 p m	White bread and butter sliced meats, cheese and tea

Rectal Saline These are best given by the drip method 600 to 1000 cc at a time, followed by a few hours rest after each dose They must be given during the first twenty four to forty eight hours after operation

After serious operations transfusion (probably given during the operation) is continued as required and is usually essential after operation for carcinoma

Respiratory Exercises Early and complete pulmonary expansion is an important factor in reducing pulmonary or pleural complications following intrathoracic surgical operations, in decreasing risk of anoxia and in obtaining maximum restoration of lung function Closed drainage of the pleural space permits air and fluid to escape in the first few hours after surgery and permits contact of the visceral with the parietal pleura This lessens the subsequent incidence of accumulation of fluid in the pleural cavity

The length of time the drainage tube is left in position depends upon a few factors to wit (a) the maximum pulmonary expansion, (b) the evacuation of air and fluid from the pleural space (c) whether the drainage tube is functioning or has been closed inside the thorax (d) whether the tube is in place It is manifest that the drainage system must be air tight at least in the first postsurgical week if drainage is to be maintained effectively

A good indication of lung expansion is the degree of oscillation of the fluid in the under water seal tube Small oscillations mean complete expansion and vice versa

Inadequate respiratory movements result from the following causes (1) pain and spasm from the abdominal incision which tends to restrict movements of the lower chest (2) postsurgical reaction associated with some degree of shock tends to cause shallow respiration, (3) excessive bronchial secretion produced during anesthesia notably by ether vapor and may not be cleared adequately by coughing (4) blocking of bronchioles by viscid mucus may result in atelectasis

Early Ambulation Newberger[1] defined the phrase as 'a daily post operative continuation of bodily exercises, including walking (not just being placed in a chair), self care in matters of toilet, dressing feeding and even actual gymnastics—directly toward an uncomplicated and rapid convalescence '

The patient should frequently be turned from side to side at least every half hour the first few days

In the recumbent position there is a decrease in vital capacity This is further augmented after abdominal operations by a decrease in diaphragmatic function and a relative fixation of the diaphragm in high position moreover the horizontal position greatly decreases the efficiency of the cough reflex

Early ambulation assists in the amelioration and prevention of atelectasis

It is sometimes possible to ambulate the patient the day following operation and daily thereafter except those who are extremely weak

A comfortable abdominal binder should be placed before the patient leaves the bed

When expedient he is asked to sit on the side of the bed on the second postsurgical day and "dangle" his legs

Bodily movements should be started immediately after surgery by means of a program of calisthenics for the upper and lower extremities This is carried out for five or ten minutes every hour while awake The patient should be allowed to sit up as soon as conscious and urged to rest his feet on a chair soon thereafter So long as the patient remains in bed such movements are continued Bodily immobility should be terminated early allowing the patient up out of bed so soon as he is fit for increasing periods of ambulation To be effective the patient should if possible start walking within 24 hours after operation Severe abdominal infections injury of the lower extremities or infection severe circulatory cardiac or pulmonary disease will usually contraindicate early ambulation

Care of the Bowels The average patient who has undergone the operation tolerates mild laxatives One fluid ounce of mineral oil or one half fluid ounce each of milk of magnesia and mineral oil may be administered twice daily the administration to start on the morning of the fourth post surgical day

Great care must be taken in ordering enemas Beginning on the second day rectal tube and glycerine suppository may be used every four hours and late in the third day or the morning of the fourth day a small cup of glycerine and water enema may be administered if necessary

Dressings The first dressing is usually carried out within 48 hours in order to inspect the surgical area Dressings are subsequently changed merely when they are soiled

Removal of Sutures Michel clamps must come out by the fifth day Silkworm gut is usually removed on the seventh or eighth day Deep sutures are usually removed much later

Retention sutures are ordinarily eliminated on the eighth or ninth day

CHAPTER XII

Complications

The various complications of gastrectomy, total or subtotal are

A Thorax

1 Lungs (a) acute tracheobronchitis, (b) pulmonary embolism, (c) atelectasis incomplete basal, massive lobar, (d) pneumonia, (e) pneumothorax, (f) infarction, (g) fat embolism, (h) abscesses, (i) empyema, (j) pleurisy

2 Heart (a) myocardial infarction, (b) congestive failure, (c) cardiac arrest

3 Mediastinum mediastinitis

B Abdomen

(1) Wound infection, (2) burst abdomen, (3) subphrenic abscess (4) peritonitis, (5) acute dilatation of the stomach, (6) gastrointestinal hemorrhage, (7) fistulas, (8) metastases (9) regurgitation, (10) postprandial fullness (11) persistent hiccough, (12) flatulency (13) postsurgical gastritis (14) persistent vomiting (15) recurrence of growth, (16) leakage from anastomosis (17) intestinal obstruction, (18) intra abdominal abscesses (19) intestinal perforation (20) stricture at gastroesophageal anastomosis (21) gastrojejunocolic fistula (22) non functioning newly formed stoma (23) dumping syndrome (24) paralytic ileus (25) looseness of bowels

C Nervous System

(1) Syncopal attacks, (2) neurotic vomiting, (3) neurotic air swallowing

D Kidneys

Urinary retention

E Miscellaneous

(1) Glossitis (2) parotitis (acute), (3) surgical shock

The complications to be expected after gastrectomy do not differ greatly from other abdominal operations but the danger of some of them is greater owing to the site of the surgical field and the severity of the surgical procedure

The first 36 hours is the time of shock and intragastric hemorrhage, on the third day as a rule is the time of respiratory complications and paralytic ileus, the seventh or tenth day one must be on the qui vive for peritonitis because of leakage at the anastomosis

Some uncommon blunders and common sequelae in gastrectomy may be listed as follows

(a) Incorrectly placed stoma making physiologic gastric emptying impossible

(b) A stoma made too small for adequate emptying with resultant obstruction

(c) A stoma too large resulting in so-called 'dumping action

(d) A too narrow attachment at the stoma permitting acute angulation and ob struction

(e) Excessive length of proximal loop inducing stasis and regurgitant vomiting

(f) A short proximal loop which causes obstruction with changing position of the stomach or from the formation of excessive adhesions

(g) Faulty fixation of the stomach to the transverse mesocolon causing internal herniation

(h) Too high fixation of the mesocolon thus forming an hour glass gastric constriction

(i) Jejunogastric intussusception

(j) Non absorbable suture material used on the mucosa interfering with stomal action and perhaps contributory to ulcer formation

(k) Volvulus, the jejunum rotates around its longitudinal axis at operation and further torsion results in volvular obstruction

(l) Adhesions around stoma influencing degree of patency

(m) Adhesions distal to the stoma

(n) Recurrent and anastomotic ulceration in some instances

(o) Fistula formation duodenal gastrocolic gastrojejunocolic

(p) Cancerous stomal ulceration

(q) Rigidity and brevity of the mesocolon which fails to stretch on filling of the stomach

(r) Pressure of the middle colic artery

Surgical Shock. This emergency may be attributable to a variety of causes among which the most common are vasomotor collapse from anesthesia (especially the spinal variety) or from traumatic and extensive surgical manipulation dehydration and blood loss

The basic feature is reduction of blood volume and rate of blood flow This causes a general vaso-constriction in an effort to maintain the blood pressure at normal level

If the initial loss of blood volume is less than two pints (the total normal blood volume is nine pints) systolic blood pressure usually remains unchanged owing to general vasoconstriction however, if the loss is greater than two pints the blood pressure falls The falling blood pressure and general vasoconstriction causes oxygen deficiency in the tissues and increase of capillary permeability In consequence fluid loss goes on into the tissues It is obvious then that restoration of blood volume is urgent As a rule two to six pints are needed as quickly as possible The indication for transfusion must be based on a clear awareness of the patient s blood pressure and hemoglobin percentage A blood pressure chart should be kept with notations every ten minutes

Signs and Symptoms In the early stage there is pallor and a raised pulse rate Later the pulse rate increases further the blood pressure falls steadily temperature is subnormal and finally the pulse becomes thready The patient is often mentally alert (when not under general anesthesia) and complains of intense thirst Vomiting is common The lips ears and fingertips are cyanosed cold and clammy

The most frequent complaint is thirst Restlessness is common (In deep shock consciousness may be lost) Respirations are usually increased sometimes sighing but true dyspnea suggests either thoracic injury or air hunger of rapid and con

tinued blood loss Renal output is greatly reduced or shut down entirely in severe shock

Treatment The level of arterial blood pressure, as previously stressed, is the best index to the degree of shock

The patient should lie supine The feet should be elevated above the head—about 12 inches is usually sufficient

Excessive application of external heat is undesirable because this serves to dilate the peripheral blood vessels and thus further embarrass the failing circulation

Care must be taken that there is adequate sedation which must be prompt, with dosage depending upon the severity of the symptoms In most instances a single dose of morphine will be effective to control restlessness and pain (Morphine should not be given to patients suffering from respiratory depression) Pentobarbital sodium (1½ grain) orally, or 2 grains by hypodermic injection, or rectal suppository may be of value

The tendency to administer drugs in shock should as a rule, be discouraged because the mechanism of peripheral circulatory failure is entirely different from that of heart failure

Plasma or serum are of the greatest value where blood is not immediately available or in insufficient quantity The response to therapy is a valuable index

In 1940 Strumai *et al* demonstrated that plasma was so efficacious as whole blood in the treatment of shock Dry plasma is superior to wet, in that it is safer may be stored indefinitely, requires small storage space and is easily transported

With a blood pressure of 100 mm or less it is usually safe to give two pints of blood quickly Normally for each pint given the pressure should rise 10 to 20 millimeters

Plasma is administered in the same way as blood but as a general rule the first pint is given comparatively rapidly, i e, 80 to 100 drops per minute Later the drip is slowed down to 40 to 60 drops per minute

Plasma also has additional advantages in that it is readily procurable is rapidly set up for administration and does not require preliminary blood typing The quantity of plasma to be administered depends upon the degree of shock and the response to its use

Five hundred cc of saline or 5 to 10 per cent warm dextrose solution or 200 cc of 5 per cent saline solution may be given rapidly (intravenously) while making preparations to give plasma serum albumen or whole blood

Anoxia present as a primary or complicating factor in shock is best overcome by routine administration of oxygen

Constant observation of the patient is imperative

Surgical Wound Infection Today infection of surgical wounds is extremely uncommon and is readily controlled by one or more antibiotics

Shambaugh[173] found that

In a controlled series the incidence of suppurative wound infection where catgut was used as suture material was twice so great as where silk was used Where fine silk (No 4) is used and the principles laid down by Halsted are followed the presence of silk in suppurating wounds does not on the average delay the healing of the wound

Glossitis This often follows total gastrectomy about the eighth or tenth day Incision and drainage are indicated for suppuration

Thoracic Complications

Pulmonary Frequent bedside roentgenograms of the thorax should be taken to ascertain the presence of post surgical complication

Age is a significant factor in thoracic complications The presence of previously known thoracic disease (cardiac or respiratory) is a predisposing element Obesity in either sex and at any age likewise definitely predisposes to thoracic complication

The specific zone where the abdomen is opened is important so far as basal collapse and bronchopneumonia are concerned The complications are commonly noted after intervention high in the area of the diaphragm This is particularly true of gastric surgery The duration of operation and the extent of visceral manipulation are also effective The selection and mode of administration of anesthesia are transcendent influences in the prevention or occurrence of pulmonary complications

Disturbances of respiration consequent upon large thoracic wounds obviously result in inadequate oxygen intake and inadequate carbon dioxide removal They also lead to disturbed gas exchange in the tissues as a consequence of low cardiac output and reduced blood circulation

Patients who manifest these disturbances are best placed on their back with the foot of the bed elevated about twelve inches (Pulmonary edema is an exception)

The main factors which induce pulmonary complications as previously stated are disturbances of respiration and retained bronchial secretions

Retention of bronchial secretions is largely avoidable if

(a) Correct nursing assistance is provided with manual support of the surgical area during coughing spells so as to ameliorate pain and increase the expulsive effect of cough

(b) Provision of adequate sedation

(c) Early use of intratracheal suction if voluntary cough is painful or unproductive

(d) Frequent change of position in bed

(e) Deep breathing exercises

Acute Tracheobronchitis Factors leading to the occurrence of tracheobronchitis include chilling of the patient whether in the operating room or in transit to the ward the presence at the time of operation of a cold sore throat or bronchial catarrh and the liberal use of ether especially in excessive concentration

Atelectasis Atelectasis is a common complication after upper abdominal operations

Prevention Bronchoscopic aspiration of mucus is invaluable in the prevention of this complication

Symptoms Symptoms usually appear within two or three days of operation There is an abrupt rise of temperature with severe general illness anxiety prostration pain in the lower part of the thorax or abdomen, increasing dyspnea and huskiness and at times cardiac embarrassment There is frequently disturbing cough with the difficult removal of thick viscid mucoid sputum

Physical Signs Examination of the thorax reveals great deficiency or absence of

air entry over the affected lobe (usually the right) with upward displacement of the diaphragm and shifting of the heart and mediastinum towards the involved side If the left side is affected the heart is not only displaced to that side but is also somewhat rotated upwards Over the collapsed lobe there is contraction of the thorax, with approximation of the ribs and inhibition of thoracic movement, as there is likewise of abdominal breathing on that side

Commonly physical signs, on examination, are to be found at the lung bases after operations in the upper abdomen, even in the absence of respiratory symptoms As a rule the signs indicate incomplete collapse of one or both lung bases, resulting chiefly from a temporary inhibition of diaphragmatic movement and consequent absorption of air from the subjacent alveoli A plug of mucus and a number of other factors may be associated to induce pulmonary deflation

The degree of postsurgical pulmonary collapse is variable depending on the general condition of the patient and particularly on the degree of local trauma in the diaphragmatic area In mild examples with but slight inadequacy of expansion of both bases, symptoms may be few or pass unrecognized, however, when more severe symptoms of mechanical respiratory embarrassment supervene there are dyspnea and cyanosis of corresponding grade and a moist but unproductive cough

The onset is usually an insidious one When the condition is established expansile movement of the thorax, as previously stated, is reduced with diminished vocal fremitus impairment of percussion note or actual dullness and weakness of breath sounds and voice conduction changing to bronchial breathing Coarse crepitations are heard on inspiration When signs are mainly unilateral only one base being involved, displacement of the heart can be discovered towards the affected side

In other examples a more abrupt and striking onset is noted owing to extensive collapse of a whole lobe or even of the entire lung—the so called 'massive or lobar collapse

Diagnosis The condition is recognized by its early onset with an abrupt rise of temperature, pulse and respiration rate and the characteristic physical signs

Differential Diagnosis

Pneumonia	*Atelectasis*
Gradual onset	Sudden onset
Occurs usually after fifth day	Occurs almost always within seventy two hours of operation
Physical signs of consolidation	Physical signs of silent consolidation
No mediastinal displacement	Mediastinum and diaphragm displaced
Sign negative	Sternomastoid sign positive on affected side
Patient toxic	Patient rarely toxic

Treatment The two principles of treatment (if preventive measures have failed) are to favor the expulsion of the mucus which is plugging the bronchi and to prevent the collapsed area of lung from becoming infected The latter objective is achieved by the injection of penicillin or sulfapyridine

After collapse has occurred the patient should be placed onto the sound side and the head lowered so that the affected lung is the highest part being raised on pillows The patient is encouraged to cough Laying the patient flat and rolling him first to

one side of the bed and then the other a dozen times often proves useful and may be repeated at intervals of four hours

Carbon dioxide 5 to 15 per cent and oxygen 95 to 90 per cent inhalations by mask are frequently effective

If after some days pulmonary collapse is still present an artificial pneumothorax may be induced The excessively high intrapleural subatmospheric pressure subsequent to collapse (minus 44 to 40 or thereabouts) is thus reduced and the displaced mediastinum returns to its normal position

Pneumonia The onset of pneumonia is usually about a week after operation

Prophylaxis Prophylactic treatment is begun in the operating room The air passages are cleared of excess secretion by means of suction and constrictive dressings are kept at a minimum Aspiration of vomitus into the lungs during recovery period is largely avoidable by placing the patient in the head-down position turning the head to the side and removing the vomitus by suction

The prophylactic use of penicillin is of value

The most severe variety of pneumonia is that which develops suddenly in an enfeebled patient As a rule the earlier the development of the disease the greater is the severity and the greater the risk of a fatal end

Another variety is that which develops usually at a later stage as a secondary pneumonic change in an area of lung already collapsed

When bronchopneumonia supervenes after an initial stage of collapse the signs and symptoms are usually of severe degree

The first variety is ushered in by rapid rise in temperature severe prostration and rapid shallow breathing There is a constant irritating cough at first dry and ineffective There is some degree of cyanosis The pulse is frequent and feeble

Tracheobronchial reflexes are diminished postsurgically When particulate matter is regurgitated it is likely to be aspirated into the lung Aspiration is therefore one of the hazards in the careless passing or removal of a stomach or other tube

Aspiration pneumonia can often be prevented by careful postsurgical supervision of patients and especially in the passing of a stomach tube

Physical Signs There are few physical signs at first with rhonci over the thorax and weak or harsh breath sounds over both bases Later there are signs of patchy consolidation perhaps bronchial breathing and scattered râles over both lower lobes Purulent frothy sputum is painfully expectorated

Treatment Before beginning treatment it is advisable to obtain sputum and blood for culture in order to determine the exact bacterial factor Treatment varies with the severity of the disease

Aside from other measures specific therapy should be carried out Aqueous penicillin in doses of 200 000 or 300,000 units dissolved in 2 or 3 cc of distilled water (or crystacillin) should be given every 12 hours for a total of three doses The dosage is continued at 24 hour intervals until the temperature is normal for 48 to 76 hours

Sulfonamides available for use are sulfadiazine sulfamerazine sulfathiazole and sulfapyridine

When the diagnosis is hypostatic pneumonia control of the primary condition is

of great importance as well as frequent change of the patient's position in bed and the earliest possible resumption of ambulation when feasible

Oxygen So long as cyanosis is present oxygen should be given by tent, mask or catheter

Oxygen concentrations up to 95 per cent may be furnished Oxygen tents are used for patients in toxic delirium who would otherwise remove the mask however the use of the tent, as a rule, is not adequate because the average concentration of oxygen then is only about 50 to 60 per cent and unless carefully controlled carbon dioxide may accumulate

Pulmonary Embolism Pulmonary Infarction Pulmonary embolism is the gravest of all complications, which usually occurs 6 to 14 days after surgery It is not uncommon in the older patient, especially if obese and/or with poor blood circulation

The embolus is usually derivative from a femoral or iliac thrombosis, though there may be no sign in the leg and may be preceded only by a slight rise in temperature and pulse rate

The embolus may also take origin from a mural thrombus in the right auricle or ventricle from subacute bacterial endocarditis

Pulmonary infarction may occur as a result of spontaneous thrombosis of a branch of the pulmonary artery, or vein particularly where there is congestive heart failure

When a small pulmonary artery is occluded the tissue normally supplied becomes ischemic and a small area of hemorrhagic exudation develops If a large branch of a pulmonary artery is occluded a widespread hemorrhagic exudation takes place in the involved area

Large emboli may cause death quickly

There are two main varieties of emboli

(1) The large, which lodges in the bifurcation of the pulmonary artery transiently occluding one (commonly the right) or both branches The onset is dramatic in its acuity The patient in a moment becomes extremely shocked pale and sweating with a sense of impending death and a strong desire to defecate The blood pressure falls the pulse becomes rapid and often irregular and may become imperceptible If the right heart fails cyanosis replaces pallor A sense of constriction or actual pain is felt in the center of the thorax Recovery occasionally takes place

(2) A small embolus which passes through the pulmonary artery, usually without causing symptoms, lodges in the lung and then causes symptoms and sometimes signs of pulmonary infarction with overlying pleurisy The right base is the area most commonly affected

The patient experiences pain in the affected area on breathing or coughing and often expectorates blood clot within 48 hours The onset may sometimes be more gradual The most common symptom in patients with small infarcts is an acute pleuritic pain over the involved area

Physical signs occasionally are completely absent but there may be a small area where crepitant rales are heard

The physical signs may be absent There may be consolidation with as aforesaid overlying pleurisy

A careful watch should be kept for signs of thrombosis in the legs They should

be examined to note (a) if one leg cools more slowly than the other (b) if there is tenderness over one leg

There may be pain oedema and cyanosis of the part with fullness of the small superficial veins in the involved leg Delayed cooling and slight tenderness especially if concurrent with a rise in temperature and pulse rate makes the diagnosis of thrombosis conclusive even if the more common signs may not be present In many patients there are few or no local signs the condition being a phlebothrombosis the most dangerous of all rather than a thrombophlebitis The patient may become extremely restless and complain of cramps in the calves The pulse rate may increase and local physical signs may be slight or absent Homans' sign may be positive (pain in the calf on abrupt dorsiflexion of the foot) or there may be tenderness on deep palpation of the calf muscles or the muscles of the plantar surface of the foot

Differential Diagnosis

Thrombophlebitis	*Phlebothrombosis*
Inflammatory process involving vein wall	Caused by hypercoagulability of blood after surgery
Femoral or iliac veins usually involved primarily	Veins of calf and plantar surface of feet primarily involved
Edema present in leg	[illegible]
If non-suppurative, no great tendency to embolism	Striking tendency to embolism

Treatment Bed rest and analgesics

A post surgical prophylactic treatment with heparin 100 mg per 24 hours comprised as a morning and evening dose of 50 mg each commencing on the day after surgery and continuing until the patient leaves his bed or at the most for 10 days gives an important protection against the appearance of thrombo embolic complications during treatment

Clarence Crafoord of Stockholm in 1935 found that heparin had less effect when given during 24 hours following surgery than when the same dose was administered pre surgically The augmented resistance to heparin in the early post surgical period was confirmed by de Takats Thrombosis can be prevented by regular treatment with heparin in adequate doses over an adequate period

Heparin can be given intravenously either continuously in saline or in single injections repeated a few times a day

A suitable dosage of heparin is 12 500 International Units and 10 000 units every four hours until the clotting time tested not less than three hours after the last dose of heparin, is not less than three times the pretreatment level The dosage should then be reduced to that figure required to maintain this prolonged clotting time probably 10 000 units four to six hourly

Total dosage per day will usually be between 50 000 and 80 000 units

Another drug in use to prevent clotting is dicumarol This is given orally the initial dose being 300 mg by mouth followed by 200 mg then 100 mg daily The dosage is raised or lowered according to the plasma prothrombin estimations as there is a lag period of some 36 to 48 hours before the drug takes effect, and as the effect

lasts for several days after the last dose given, it is not nearly as suitable as heparin for the treatment of postsurgical thrombosis

Ligation of the femoral vein is sometimes carried out to prevent pulmonary embolism (Ligation of the inferior vena cava has been performed for the same reason)

Ligation may become urgent when embolism has occurred in spite of heparin and where there is septic phlebitis and risk of septic pneumonitis

Oxygen, in high concentration (100 per cent) either by tent nasal catheter or mask, should be given to every patient Almost all patients who have had a major thoracotomy have a reduction in the arterial oxygen saturation for a few days because of various factors interfering with a proper correlation between pulmonary ventilation and pulmonary circulation

Papaverine 0 03–0 06 Gm (½ to 1 grain) and atropine *sulfate intravenously* every three or four hours are given This helps to overcome the general pulmonary arteriolar spasm that supervenes Morphine sulfate or demerol helps to control the pain If shock is present intravenous use of fluids should be cautious because of the possibility of precipitating acute right heart failure especially in those with previous heart symptoms If this occurs venesection is advisable

Early ambulation should be encouraged so much as possible for patients who underwent esophageal resection

Leg exercises before the patient is out of bed should be carried out

Pulmonary Suppuration Five varieties of pulmonary suppuration occur postsurgically, namely

(a) Diffuse suppurative pneumonitis
(b) Necrotizing pneumonitis
(c) Pulmonary abscess
(d) Empyema
(e) Subphrenic abscess

Pulmonary Abscess The surgical procedures occasionally followed by lung abscess are those of the upper respiratory tract Almost always the abscess results *from the inhalation into a bronchus of infective material or foreign body*

An aspiration abscess is more often found on the right side than the left The upper zone of the lower lobe is the site most commonly involved (Embolic abscesses occur chiefly at the periphery of the lung)

The development of an acute inhalation abscess is usually revealed by the onset of severe respiratory symptoms at an interval following surgery of from six to ten days or longer There is cough malaise *chills fever and pleurisy*, with or without effusion The patient becomes extremely toxic and his breath becomes foul Sometimes a large amount of pus is coughed up

Physical signs roentgenograms and bronchoscopy are of great help in confirming and localizing the lesion

The signs vary with the size position, contents of the cavity and local pulmonary reaction

A smear and culture of the sputum are made to determine the predominant organism and the antibacterial agent or agents are used which will most *effectively* combat the infection

Penicillin 300 000 units (aqueous) should be given intramuscularly every three

hours and streptomycin 0 5 to 1 00 Gm every six hours orally Sulfadiazine sulfamerazine or a mixture of the two 4 0 Gm as a first dose and 2 0 Gm every four to six hours

Surgery is in order if the patient fails to respond to treatment and especially to bronchoscopic aspiration

Empyema Empyema usually results from a spread of infection from contiguous structures commonly the lungs It may occur as a complication of pneumonia pulmonary abscess, tuberculosis mycotic pulmonary disease bronchiectasis or spread of infection from the thoracic wall mediastinum pericardium or subdiaphragmatic areas

Pleurisy Pleurisy often accompanies inflammatory lung disease and may complicate mediastinitis pericarditis infections of the thoracic wall and subdiaphragmatic disease It may also be associated with pulmonary infarction malignancy and trauma of the thoracic wall

Pleurisy may occur after abdominal operations by a direct upward spread of infection through the muscular fibers of the diaphragm or extraperitoneally from the peri renal cellular tissue The spread is usually over the thoracic aspect of the diaphragm and the adjoining lung base

Pneumothorax Pneumothorax sometimes follows faulty esophagoscopy or bronchoscopy

The lung is collapsed against the vertebral column The mediastinum and heart are drawn to the opposite side

Symptoms The symptoms of acute pneumothorax depend in the main on the rapidity and degree of its development As a rule there is a sudden sharp pain in the thorax dyspnea and sometimes a dry persistent cough

The pain may be felt in the corresponding shoulder across the thorax or over the abdomen Signs of shock and circulatory collapse are uncommon

Physical Signs If there is a large amount of air in the pleural cavity there are immobility and bulging of the affected side The apex beat is to the opposite side

Tactile fremitus is diminished or absent On percussion there is tympany or cracked pot resonance Cardiac dullness is elicited to the right Displacement of cardiac dullness and apex beat away from the affected side is more evident on expiration than on inspiration On auscultation there are absent or diminished breath sounds on the affected side and increased breath sounds on the opposite side—as of wind blowing over the mouth of a distant cavern There are coarse rales The coin sound is present when there is positive pressure pneumothorax (The test can be made by striking a coin laid on the thorax with another coin or by merely flicking the thorax with the thumb)

Diagnosis The diagnosis can usually be made solely from the physical signs but the history obtained is frequently characteristic The patient while coughing suddenly experiences pain in the chest and intense dyspnea which persists The onset may however be insidious with few symptoms

On roentgenographic examination there is as a rule a characteristic absence of lung markings peripherally with a definite lung margin A small pneumothorax can be detected on taking an exposure during the expiratory phase

Differential Diagnosis The condition must be differentiated from other causes

of cardiac displacement—fibroid lung for example, pleural effusion dextro cardia subdiaphragmatic abscess containing air, diaphragmatic hernia, flatulent distension of the stomach and emphysema

Treatment If symptoms of tension pneumothorax are present (or indications of bilateral involvement) aspiration of air from the affected pleural cavity is urgently necessary Enough air should be removed to ameliorate the symptoms and bring the intrapleural pressure to normal

If there is recurrence of respiratory distress a blunt needle should be left in place in the pleural cavity connected by rubber tubing to a water tap (The end of the tubing should not be more than three or four inches below the level of the water in the container) Maintenance of effective suction obviates the hazards of pleural effusion hydrothorax and hemothorax

Oxygen is administered for the dyspnea during the acute stage Sedatives, too may be given

Cardiovascular Complications The chief predisposing factors in post surgical cardiovascular complications are age loss of blood, exhaustion from pain cold and exposure, and surgical trauma

The main cause of post surgical heart failure and death is a reduction in the amount of oxygen brought to the cardiac muscle

Myocardial failure and dilatation is of frequent occurrence in the obese and elderly patient with fatty degeneration of the heart The great strain of operation and the circulatory disturbances consequent upon anesthesia induction combine with shock and hemorrhage to produce failure

Digitalis is of great value in the therapy of post surgical auricular fibrillation and cardiac failure Cardiac arrhythmias are not uncommon following esophago gastrectomy

Paroxysmal tachycardia is a fatal complication unless easily controlled Intra venous administration of procaine is dramatic in the relief it affords

Mediastinitis Acute mediastinitis, or cellulitis of the mediastinal connective tissue is an infrequent complication of surgical intervention in the thorax

Symptoms In the mild infections the symptoms may be slight, absent or inconclusive In the more severe forms there are pressure symptoms—pain in the thorax tenderness over the sternal area spine or shoulder blades and severe general illness There is paroxysmal cough hoarseness, stridor, dyspnea and at times dysphagia Cyanosis with venous engorgement of the neck and upper limbs follows in time

Roentgenograms of the superior mediastinum reveal lateral widening of the shadow in the area in question In suppuration within the posterior mediastinum the space between the esophagus and the vertebral column is partly or completely obliterated In anterior mediastinitis the heart shadow is distorted

Treatment The patient is placed on the table in the dorsal horizontal position

1 Transverse incision at level of upper border of third costal cartilage, extending just beyond borders of sternum
2 A second transverse incision at level of lower border of fifth costal cartilage
3 Left ends of these two incisions connected by a vertical one
4 Incisions deepened to sternum and ribs

5 Sternum divided at level of upper and lower transverse incisions with Gigli saw

6 Costal cartilages divided

7 Remaining soft tissues severed

8 Osteoplastic flap reflected to right thus exposing mediastinum

9 Drainage established

10 Osteoplastic flap reposited

11 Wound closed in layers with chromic catgut sutures

The superior part of the mediastinum (which is above the upper level of the pericardium), it should be recalled contains the origins of the sterno hyoid and sterno thyreoid muscles and lower ends of the longus colli muscles the aortic arch the innominate artery and the left common carotid (in part) and subclavian arteries the innominate veins part (upper half) of the superior vena cava left superior intercostal vein trachea esophagus thoracic duct thymus gland lymphatic glands the phrenic nerve the vagi cardiac and recurrent laryngeal nerves and directly behind the upper part of the sternum the thyroid gland

The superior mediastinum can be surgically approached through the suprasternal notch or by an incision parallel with and directly anterior to the sternocleidomastoid in the lower part of the neck

The posterior mediastinum contains the descending aorta azygos veins pneumogastric and splanchnic nerves esophagus thoracic duct and lymph glands

The posterior mediastinum can be reached below the sixth dorsal vertebra by thoracotomy The path taken depends obviously upon the level of the abscess

The anterior mediastinum (between the sternum and pericardium) contains areolar tissue, triangularis sterni muscle branches of the internal mammary artery lymphatic vessels and glands

Drainage of the anterior mediastinum is carried out as for pericarditis

Abdominal Complications

Wound Disruption and Burst Abdomen Prophylactic treatment consists in clean cutting of the wound aseptic technic and good packing transverse or valvular incisions provision of vitamin C attention to hemostasis in the abdominal wall and adequate anesthesia when sewing the wound Proper sutures materials are essential

Some conditions are known to predispose to burst abdomen The more important are

1 Violent or persistent cough
2 Infection of laparotomy wound
3 Intestinal obstruction with distension
4 Acute pancreatitis
5 Faulty closure of wound
6 Ascites
7 Extreme debility of the patient

The immediate treatment is to cover the wound and the prolapsed contents with hot moist gauze Morphine is given Surgical repair is carried out

Hemorrhage Hemorrhage from the anastomotic line is commonly caused by faulty surgical technic

Some stale blood may be aspirated after gastrectomy and anastomosis If the hemorrhage is persistent frequent aspiration is done and 1 cc of adrenalin left in the stomach is often effective However, if bleeding is profuse enough to be vomited around the Levine tube re operation is urgently indicated

In severe hemorrhage the time, rate and volume of blood administered must meet the physiologic needs Large amounts of blood may be given as indicated—especially when the number of red corpuscles falls below 2,500,000—if immediate surgery is contemplated or if symptoms of anoxia or shock are not rapidly brought under control Slow and continuous administration of 500 cc up to 2500 cc of whole blood daily may be required

Hemorrhage from the jejunum is less common than from the stomach if the anastomosis has been placed correctly with the incisional line in the free border of the jejunum directly opposite the mesenteric attachment

Sometimes there is hemorrhage from faulty ligation of vessels in the omentum majus or minus

The main precaution in the surgical technic is precise ligation of gastric submucous vessels at the site of anastomosis These vessels are well observed after division of the sero muscular coat and should best be ligated prior to opening the gastric lumen In order to secure safe hemostasis each vessels must be ligated with No 00 catgut on a round needle enough of the sero muscular coat being included to prevent the stitches from tearing out

Treatment The patient must be kept completely at rest The blood pressure is kept down He is given 1/6 grain of morphine hydrochloride subcutaneously and 1/100 grain atropine sulfate to decrease secretion of gastric juice No food or drink is given for 48 hours The mouth is kept clean to prevent parotitis Fifteen ounces of normal saline solution are given every six hours by rectum The colon is kept empty by means of a daily enema of plain water Dehydration is overcome in the customary manner

A drachm of tribasic magnesium phosphate in a small quantity of water is given every three or four hours in order to neutralize the free acid present in the stomach and so prevent the digestion of the forming clot The hemoglobin percentage should be estimated daily If it falls below 45 per cent the patient should be transfused without delay The blood pressure should be measured at least twice daily as a fall of blood pressure precedes a fall in hemoglobin when bleeding occurs It may be necessary to repeat the transfusion two or three times

Regurgitation This complication is common in the thoraco abdominal approach for total gastrectomies in which the esophagus has been shortened and the diaphragm reconstituted It often leads to esophagitis stomatitis and glossitis

Intestinal Distension Jones[174] made experimental studies in human beings from balloon distension of various parts of the digestive tract He found that the effect in the duodenojejunal angle produced pain in the umbilical area distension of the ileum or jejunum induced umbilical pain pain in the jejunal area was experienced a little higher than that arising from the ileum distension of the ascending transverse or descending colon, produced pain referred to the hypogastrium toward the midline

One hundred per cent oxygen is often used for the relief of the condition The Miller Abbott tube is found to be effective The rationale for the use of 100 per cent oxygen is that it reduces the nitrogen present in the intestinal tract by replacement with oxygen an absorbable agent because of the tendency of the body to bring about equilibrium of gases

(A full large sized standard cylinder at 2 200 pounds pressure when delivering oxygen at a rate of six liters a minute lasts about nineteen hours The inhalation of 100 per cent oxygen should be interrupted for a few minutes at least every ten to twelve hours)

Postprandial Fullness This commonly tends to improve as time goes on

Flatulence Flatulence causes great postsurgical distress Oil of cajuput, 3 m on a piece of sugar is often ameliorative A rectal tube may be passed and left in position for an hour Pitressin hypodermically administered is helpful in relieving the discomfort

Hiccough The centers controlling the respiratory muscles (which are in the upper cervical part of the spinal cord) may be affected

Various simple measures may be tried Sometimes extremely effective is pressure on the carotid between the thumb and forefinger for one minute the artery being grasped at the mid point of the anterior border of the sternocleidomastoid Strong digital pressure may be applied over the phrenic nerves in their course behind the sternoclavicular joints

If all the simple methods prove ineffective temporary interruption of the phrenic nerve may be accomplished on the side corresponding to the leaf of the diaphragm involved as determined by fluoroscopy Local infiltration of the nerve can be attempted with procaine 20 to 30 cc of a 0 5 per cent solution the needle being inserted down to the anterior scalenus muscle at a point directly above the clavicle at the lateral border of the sternocleidomastoid

A small dose of morphine sulfate and atropine or an injection of ether (1 cc) subcutaneously is sometimes effective Adrenalin may be administered and often proves adequate

Acute Dilatation of the Stomach This is an infrequent complication of gastric or intestinal operations

The actual cause is unknown In the main the condition is probably owing to reflex inhibition of the gastric motor nerves by way of the autonomic system

Some theories are to the effect that the dilatation is occasioned by one or more of the following causes (1) obstruction of the third part of the duodenum by the superior mesenteric artery and vein (2) excessive secretion of gastric juice (3) spasm of the pylorus (4) toxic paralysis of the neuromuscular mechanism analaogous to paralytic ileus (5) division of the vagus nerves (6) excessive handling of the stomach

The dilatation usually involves the duodenum also and sometimes the jejunum

The enormously dilated stomach occupies almost the entire abdominal cavity The intestines are jammed into the pelvis or behind the dilated stomach

Symptoms The acute dilatation ordinarily commences suddenly from twelve to forty-eight hours after operation The stomach rapidly becomes distended with gas and fluid The patient vomits and is usually in a state of shock

The abdominal distension is preceded and accompanied by discomfort pain tender

ness, tightness and a sense of fullness The distension is most prominent in the epigastrium, particularly on the left side and rapidly extends downwards filling the left flank, bulging into the hypogastrium and finally completely inflating the abdomen

With each vomit large quantities of gas and fluid may be belched up The vomitus material is at first colorless, then bile stained and finally yellow brown brown or black (Some patients do not vomit) Hematemesis may occur if the dilatation is not quickly relieved

The patient is restless, complains of intense thirst The pulse is rapid and the respiratory rate increased and dyspnea supervenes largely owing to elevation of the diaphragm The upper abdomen becomes distended, tympanitic with obvious succussion splash, but no visible peristalsis

Alkalosis, tetany and finally shock may develop in consequence of fluid and electrolyte loss

Roentgenographic Examination Roentgenographic examination usually reveals the characteristic shadow of a gas filled stomach

Diagnosis The diagnosis is highly suggestive if in the post surgical period the patient s abdomen suddenly becomes greatly distended and he vomits profusely

Differential Diagnosis The condition must be differentiated from (a) post anesthetic vomiting, (b) acidosis (c) leakage from the anastomosis, (d) edema of the stomach, (e) acute peritonitis, (f) paralytic peritonitis, (g) high intestinal obstruction, (h) intraperitoneal hemorrhage (i) acute poisoning by drugs

Treatment The principles of treatment are as follows (a) empty stomach, keep it empty (b) give continuous intravenous saline, (c) postural arrangement (d) oxygen administration, (e) surgical intervention should *never* be attempted

There must be early postural treatment aspiration and lavage of the stomach intravenous and subcutaneous transfusions of saline and the administration of drugs such as morphine

The end of the bed should be raised at least 18 inches upon blocks or on a chair The patient should be turned over face downwards with a pillow under the pelvis

A small bore stomach tube should be used for aspiration and irrigation The tube should be connected to a continuous suction apparatus (The patient should be in the Trendelenburg position when the stomach tube is passed) The irrigation should be with normal saline carried out every half hour The aspiration and irrigation must be continuous until it is evident that the stomach is regaining its tone

At first 250 cc of 2 per cent saline is given intravenously, followed by normal saline at 50 to 60 drops a minute Frequent blood chloride and carbon dioxide combining power determinations should be made to estimate the amounts of saline solution required

So soon as the water or saline removed from the stomach is less than administered the tube may be removed

Gastritis The gastritis is usually of a superficial atrophic variety

It has been known for many years that there is some predisposing relationship between atrophic gastritis and gastric cancer

On gastroscopic examination the gastric mucosa shows the following features hyperemia small purpuric spots or ulcerations

The chronic atrophic variety is characterized by a gray or greenish gray dull color

ation and thinning of the mucosa, absence of rugae and by readily observed blood vessels in the atrophic areas Mucosal hemorrhages are not rare

Signs and Symptoms The patient complains of poor or lost appetite and weight nausea and vomiting The nausea and vomiting in the morning is a common feature There is frequently a great deal of flatulence and constipation is usually present

Atrophic gastritis is often concurrent with pernicious anemia In pernicious anemia there is an extreme atrophy involving all coats of the stomach wall This change is localized in the upper two thirds of the viscus leaving the pyloric antrum and duodenum unaffected In the affected area the stomach wall is extremely thin There is an absence of inflammatory change

Diagnosis Gastric analysis often shows achlorhydria and excessive amounts of mucus

Differential Diagnosis

Chronic Gastritis	*Gastric Ulcer*
Diffuse pain after food	Pain localized after food
Morning vomiting	Vomiting soon after taking food
No hemorrhages	Hemorrhages common
Free HCl often normal	Free HCl in excess
Stomach often enlarged	No enlargement tender spot on palpation

Treatment The diet should be bland and taken frequently in small amounts Supplementary vitamins of the B complex and ascorbic acid should be given Foci of infection in the mouth and pharynx are best eliminated

Sometimes gastric lavage is helpful

Retained silk sutures with severe associated ulceration stomal obstruction or other mechanical factors of course demand surgical correction

Persistent Vomiting When this occurs after gastrojejunostomy for example it may be induced by any of the following conditions

(a) Vicious circle vomiting

(b) Acute dilatation of the stomach

(c) Paralytic ileus—with or without peritonitis

During the first forty eight hours after gastric surgery some patients regurgitate bile in varying quantities The vomitus is measured and chartered

A gastric aspiration tube is passed intranasally as a routine Feedings are stopped and fluids supplied parenterally After twenty four hours feeding is resumed with the tube still in place If at the end of a day there has been no vomiting the tube is removed

If after 48 hours vomiting commences or large quantities of bile are recoverable by gastric aspiration the presence of a nonfunctioning stoma may be suspected

(It is a matter of divergent opinion whether or not it is advisable to introduce a Levine tube past the gastroesophageal anastomosis and into the intrathoracic part of the stomach at the time of operation or immediately thereafter It is maintained that an indwelling tube resting on the suture line may predispose to ulceration and interference with healing Some surgeons recommend jejunostomy so that alimentary feedings can be given promptly after operation)

Nonfunctioning Stoma Gastric evacuation through the pylorus or through a

gastroenteric anastomosis may be retarded by hypoproteinemia But other factors are involved as shown by Chauncey and Gray[175] Quigley[176] experimented on dogs and demonstrated that the role of the pylorus is secondary and gastric evacuation is mainly controlled by gastroduodenal pressure gradients Abbott et al[177] apparently proved that the same was true of man It is manifest, therefore that poor gastric evacuation after subtotal gastrectomy in some patients is not solely owing to an inadequate stoma but is induced by a flattened or reversed gastroenteric pressure gradient

Leakage from the Anastomosis This may be occasioned by one of the following factors

(a) Stomach insufficiently mobilized
(b) Failure of anchoring stomach to pleura
(c) Inadequate proteins and vitamins in the diet
(d) Faulty suturing

(An anastomotic ulcer may begin in the jejunal mucosa at the site of anastomosis)

According to Somervell,[178] leakage from the stump of the duodenum, for instance can be avoided if

'(a) Catgut is used in the anastomosis and at times an additional layer of interrupted, non absorbable sutures is used
(b) Devascularization of the part is avoided
(c) Circumspect suturing is accomplished
(d) Decompression of the part with use of Ryle's tube or similar one
(e) Reinforce suture line by superimposition of an omental graft

Symptoms The patient vomits and experiences sudden pain There is tenderness and rigidity in the involved area

Treatment The duodenal tube must immediately be passed and the patient fed in this manner

Adequate doses of antibiotics are given and the patient is prepared for re operation to repair the leakage site

Intestinal Perforation Perforation is rare When it occurs radical operation is not to be considered

Peritonitis The peritoneum and the fluid produced by it are as is known *ideal* culture media

Peritonitis is perhaps the gravest complication In the great majority of patients it is caused by suture line defects in the anastomosis or in the duodenal stump

The peritonitic symptoms usually occur in the course of the first four to five days after surgery

The symptoms are extremely variable depending in the main on the causative agent the pathologic process that develops and the presence of complicating factors

The signs and symptoms are too well known to require re emphasis

In the Billroth II gastric resection the duodenal stump is always a possible site of leakage however, when careful mobilization accomplishes the formation of an adequate duodenal stump which is buried in three sutural layers without tension the risk of leakage from the stump is slight

Mobilization of the duodenum is made circumspectly so that there is no unnecessary trauma to the vascular supply and the peritoneal covering of the intestinal

walls and the possibility of necrosis is obviated When it appears that duodenal suturing may be insecure it can be protected by an omental covering (The head of the pancreas should never be used to cover the suture line)

Injury to the pancreas involves the greatest risk of sutureline defect because the pancreatic juice which flows out causes quick resorption of the sutures in the duodenal stump

If there is considerable doubt as to the adequacy of the duodenal stump drainage must be established from it for at least one week

Diagnosis The diagnosis of peritonitis is usually confirmed after determination of the primary disorder At times differentiation must be made from renal or lead colic pneumonia rheumatic fever twisted ovarian pedicle and gastric tabes

The leukocyte count abdominal paracentesis roentgenography peritoneoscopy and exploratory laparotomy are all aids in arriving at a conclusive diagnosis

A major intraperitoneal leakage is fatal unless the contents find an outlet through the abdominal wall resulting in an external fistula which often closes spontaneously An anastomotic fistula is more often fatal than a fistula from the duodenal stump

Treatment of Postsurgical Peritonitis Pre and postsurgical use of antibacterial agents have served miraculously in lowering the incidence of peritonitis as a com plication of gastrointestinal surgery as of all abdominal surgery

Penicillin and sulfadiazine in combination are extremely effective in combatting peritonitis caused by gastrointestinal tract complications Streptomycin dihydro streptomycin aureomycin and chloromycetin may be administered in addition to penicillin and sulfonamide until the infective organism has been isolated and identi fied

The focus of infection must be removed if possible or drained

An ample supply of fluid rectally and intravenously should be provided The stomach must be kept empty with permanent intra nasal suction

Balfour recommends placing a catheter in an external fistula and applying perma nent suction to this and also to make a jejunostomy A gastrostomy may be in dicated

Nothing should be given by mouth Food and fluid requirements are provided by parenteral administration of 5 per cent dextrose solution isotonic sodium chloride solution or hydrolysates Transfusions of blood or plasma are beneficial

Intestinal Obstruction Intestinal obstruction as a post surgical complication has been variously designated

(a) Circulus vitiosus
(b) Regurgitant vomiting
(c) Gastric atony
(d) Gastric *dilatation*
(e) Gastric ileus
(f) Spasticgastro enteric block

Surgical operations on the stomach are not infrequently followed by disturbances in the motor function of the organ, sometimes of greater sometimes of less degree A certain amount of intestinal paresis is also the consequence of these operations especially of gastroenterostomies

These disturbances change with the extent and duration of the intervention

from being slight and rapidly transient to becoming *protracted and severe* When resection is accomplished (especially on the lesser curvature), with ligation of the hepatogastric ligament, there is severe injury to branches of the vagus nerve which pass in the omentum minus, while the sympathic nerve branches in the omentum majus are less affected In this way the sympathetic nerves from the coeliac plexus which have an impeding and tonus reducing effect on gastric muscles become over all effective when the vagus branches are severed

Injuries to the vagus nerve are therefore of decisive *importance to post surgical* gastric motility

There are two varieties of obstruction which at times follow gastroenterostomy or *resection They are caused* either by edema or mechanical interference with peristalsis

A degree of edema caused by surgical trauma commonly lasts from 48 to 72 hours

The causes of paralytic ileus often are

(a) Prolonged operation associated with excessive or rough handling of the intestine

(b) Forcible retraction of wound edges

(c) Over cooling the bowel from exposure to air

(d) *Peritonitis* (spreading or localized)

(e) Mesenteric thrombosis or embolism

The mechanical causes are

(a) The anastomosis may be drawn into the lesser omental cavity through the mesocolon This sometimes occurs in posterior gastroenterostomy and in post colic anastomosis following resection

(b) Adhesions forming angulation and obstruction of jejunal loop distal to the *anastomosis*

(c) Obstruction and dilatation of the long proximal loop in the ante colic variety of anastomosis with resection in which an anastomosis has *not* been accomplished between efferent and afferent loops of jejunum

If obstruction is persistent after the plasma proteins and fluid balance have been returned to normal mechanical obstruction is probable

Obstruction of the proximal loop in gastric resection is most serious and *rapidly fatal unless surgical intervention is prompt* (The proximal end of the duodenum has been closed during resection and the duodenum becomes greatly and rapidly distended with its own secretion and with the total bile and pancreatic secretion)

The condition is then characterized by a completely inhibited or inadequate passage of gastric contents into the intestine, with the result that ingested food and secreted gastric juice are left stagnating in the stomach in which flow, in most instances biliary, pancreatic and duodenal secretions *The* gastric contents are then either vomited or have to be withdrawn by means of a stomach tube If the obstruction is not relieved within a few days the loss of these digestive fluids (with the ions contained in them) and the ensuing inanition lead to a rapid deterioration in the patient's condition

Obstruction sometimes follows ante colic long loop gastroenterostomy (*with or* without resection) and entero-anastomosis between the *limbs of a loop* The loop used for gastroenterostomy has been too short with the result that the afferent loop

becomes too distended and consequently paretic The stomach contents empty into this paretic part of the bowel (in an anti peristaltically directed cul de sac) In order to avoid the hazard of distension paresis the loop in this variety of gastroenterostomy must be taken at least 50 cm long measured on the *contracted* intestine

After posterior short loop gastroenterostomy (with or without simultaneous re section) the obstruction may also be attributable to the fact that the gastroenter ostomy loop is too short so that it becomes distended and consequently paretic The commonest causes of obstruction after this kind of operation however are changes in the mesocolon in the form of fibrous thickenings high grade fat content and ex treme brevity These changes cause such pressure and compression of the gastro enterostomic loop that the relatively weak motility of this part of the bowel cannot overcome the obstruction

After large resections the mesocolon may be pulled up so much that it compresses the loop of gastroenterostomy likewise with obstruction as a sequel

In the average patient who makes a good recovery from a subtotal gastrectomy roentgenoscopic examination of the gastric remnant shows that this may be slightly atonic in the early postsurgical period but subsequently it becomes small appears to show a high degree of tone and is often without a gas bubble Ingested barium enters the small intestine rapidly so that the gastric emptying time is usually much less than that of the normal stomach In time however the function of the gastric stump improves a change that is brought about by elongation of the greater curvature The gas bubble reappears and the stomach again takes on some of its reservoir functions however the general motility pattern tends to be abnormal

Immediately distal to the anastomosis the small bowel may dilate and form small additional reservoirs in which the intestinal content pools before being passed farther down the intestine This is especially true if the gastric remnant is small or if total gastrectomy has been performed jejunal reservoirs may become large and permanent

In summation the causes of intestinal obstruction following subtotal gastrectomy and anastomosis may then be grouped as follows

(1) An improperly placed stoma (The position of choice is the most dependent part of the stomach and the long axis of the stoma should be nearly at right angles to that of the stomach)

(2) A stoma too small or so narrow of attachment as to produce acute angulation of the jejunum

(3) A proximal loop of excessive length or of such brevity as to obstruct with changing positions of the stomach

(4) A rigid or short mesocolon which fails to stretch on filling of the stomach

(5) Inadequate fixation of stomach to mesocolon

(6) Internal herniation

(7) Adhesions around stoma

(8) Pressure of middle colic artery

(9) Marginal or jejunal ulcers at or near stoma

(10) Adhesions distal to anastomosis

(11) Hypoproteinemia

According to Somervell[1,3] mechanical ileus after *gastrojejunostomy* may be caused by

(1) Kinking of the small intestine due to faulty position of the stoma
(2) Kinking due to the slipping of the mesocolon over the anastomosis owing to faulty suture *of the mesocolon to the stomach*
(3) Adhesions to the abdominal wound preventable by suturing the peritoneum so that its cut raw edges are turned outwards
(4) Adhesions secondary to gastrojejunal ulcer or to some other inflammatory condition in the abdomen
(5) Herniation of the intestine into the lesser sac through the opening in the mesocolon preventable by proper suture of the mesocolon to the stomach wall
(6) Intussusception of the jejunum through the stoma into the stomach
(7) Herniation of the intestine through the space between the jejunal flexure and the anastomosis

Symptoms There are severe epigastric pain, frequent vomiting and a steady deterioration in the general condition of the patient evidenced by a rise in pulse rate sunken facies and cyanosis

The abdomen becomes distended by degrees and the patient complains of colicky pains Constipation is absolute

In paralytic ileus the onset usually is with persistent vomiting of brown, offensive fluid, abdominal distension a rise in pulse rate and obstinate constipation for flatus and feces The temperature becomes subnormal, the extremities cold and livid, the eyes *and features sunken but there is complete absence of pain*

Diagnosis In examples of retention following gastric surgery it is of first importance *to attempt to determine the variety A gastric retention for the first few days* may, as we have seen, be owing to edema at the anastomosis, caused by surgical trauma If this persists beyond that period *hypoproteinemia should be suspected* Total plasma proteins below 5 2 grams per 100 cc. usually produces edema *although* this point is not fixed and varies with dilution of the plasma *and the total amount* of sodium chloride given

Treatment To begin with it may be said that the *obstruction is overcome* spontaneously in the majority of patients

There are divergent views among surgeons regarding the *treatment of paralytic* ileus Some believe that stimulation with the use of drugs is the treatment of choice but others hold the contrary view

Gastric aspiration should always be resorted to as well as continuous intravenous saline and glucose Cajuput oil, 1 minim should be given *A turpentine enema often* is effective

Spinal analgesia is useful when other measures fail

Pitressin ½ cc is given early intramuscularly or prostigmine (0 5 mg) injections of pituitrin or acetylcholine may prove of value

Conservative measures consist of

(a) Gastric lavage
(b) Careful calculation of the water balance, with maximum dextrose and limited salt
(c) Administration of protein in the form of whole blood or blood serum (250 cc or more daily)

(d) Feeding of thick gruel after the stomach has contracted and the dextrose, protein salt and water balance is corrected

When the results of diagnostic procedures suggest a mechanical cause of the retention which can only be relieved surgically indication is present for re intervention The operation should be accomplished before the general condition of the patient becomes too severely affected and his power of resistance is too much reduced

The secondary operations of choice depend on what is found at re-operation but a jejunostomy distal to the anastomosis is best carried out in most instances

The next secondary operation of choice is enteroanastomosis between the distal and proximal loops It is indicated when the anastomosis has been pulled into the lesser omental sac through the opening in the transverse mesocolon It is also indicated in the antecolic variety of resection when the long proximal loop does not empty well and when the obstruction is in the proximal loop near the anastomosis

Renewed intervention after gastrojejunostomy and resection may in general take the form of

(1) Severance of adhesions
(2) Removal of the gastrojejunostomy and placing of new one
(3) Jejunojejunostomy
(4) Duodenojejunostomy
(5) Gastrostomy
(6) Jejunostomy
(7) Forming a new gastrojejunostomy
(8) Resection of stomach with gastrojejunostomy and placing of new gastrojejunostomy or gastroduodenostomy

Division of Adhesions This is a simple procedure The breaking up of adhesions which may be found distal to the anastomosis quickly relieves the obstruction The release of adhesions *near* the stoma however frequently fails to give permanent relief

Removal of Gastrojejunostomy When the evacuation inhibition after gastrojejunostomy is owing to the anastomosis and the pylorus is passable the gastric passage may be restored by removing the anastomosis The stomach and jejunum are separated at the site of anastomosis and the openings are closed thereby re establishing the conditions existing before the first intervention (In retrocolic anastomosis this procedure may prove difficult) It also has the additional disadvantage that after the operation is performed the patient is just as gravely ill perhaps worse than prior to the first operation

(Few patients survive restoration of intestinal continuity by removing the anastomosis)

Jejunojejunostomy Connection between the afferent and efferent anastomotic loops is indicated primarily for the patient when after gastrojejunostomy or resection an obstruction is present to the passage through the afferent anastomotic loop

Duodenojejunostomy It may be necessary to accomplish a duodenojejunostomy between the retroperitoneal part of the duodenum and efferent jejunal loop The anastomosis is placed at the deepest horizontal part of the duodenum The mobilization of the duodenum should be made at the base of the transverse mesocolon on its dorsal aspect

Gastrostomy When re operation reveals no strangulation, kinks of the anastomotic loops, or great constrictions in the anastomosis owing to faulty surgical technic as the cause of gastric obstruction it may be assumed that the difficulty is owing chiefly to a combination of atony of the stomach and hypertrophic mucous membrane at the site of anastomosis

Jejunostomy The jejunostomy should be carried out in connection with a gastrostomy (It may prove wholly inadequate)

The Dumping Syndrome The post gastrectomy or gastrojejunostomy syndrome is a jejunal effect caused by sudden gastric emptying It is maintained by some surgeons that food can be prophylactically delayed in its exit from the stomach by a variety of anastomosis—the double valve The stoma is in the middle of the resected end of the stomach the remainder being closed by an upper and a lower valve

When the reservoir function is lost food leaves the stomach rapidly in large quantities and in an unprepared state When the trituration function is impaired, large pieces of food which are not readily digestible, are passed into the small intestine

Following a Billroth II operation there is an accelerated evacuation of stomach contents in the erect position In some examples the "Billroth II stomach" empties an ordinary opaque meal in about four to six minutes The ordinary evacuation may be rapid, an ordinary opaque meal in the course of ten to thirty minutes In the supine position the evacuation of the 'Billroth II stomach is entirely different from that in the erect position because gravity (which is the main propulsive force in the 'Billroth II stomach") is extremely deficient the evacuation is therefore not accelerated and in some examples it is slower than in the normal stomach

The impairment of gastrointestinal function is shown for example, by intake excretion studies of fat The effect is probably owing to reduced gastric function and to the inability of the small intestine to compensate completely for the added "work" thrust upon it

Symptoms There are (a) a sense of warmth (b) sweating, (c) fullness (d) distension (e) pain in the epigastrium, (f) nausea (g) palpitation, (h) weakness (i) vertigo (j) flatulence (k) diarrhea

These manifestations vary in severity and occur suddenly, as a rule

The mechanism of production of the symptoms has been variously ascribed It has been maintained that they are caused by hypoglycemia hyperglycemia and by mechanical distension of the jejunum caused by the 'dumping" of food into it In general after several months severity of these symptoms appears to lessen to some degree Vomiting is not a frequent occurrence However, in most patients the distress persists

Machella[179] believes that

> The early post prandial dumping symptoms are due to distension of the jejunum by fluid which enters the lumen of the gut from the blood stream in response to the presence of a hypertonic solution from the ingredients of a meal possessing osmotic properties and not to distension by the bulk of ingested food They are not caused by hyperglycemia though a hyperglycemia may be present during the period of symptoms

The rate of absorption in the intestine it will be recalled is controlled by physico chemical factors and by the blood supply to the intestinal wall In many instances absorption is speeded by solution of foodstuffs in fats oils or alcohols

In the stomach there is some relationship between the motor and secretory functions Vagal stimulation increases the two effects and vagal section decreases them Thus, after transthoracic or transabdominal vagotomy gastric tonus is greatly reduced and gastric emptying as a rule is delayed

Lusterman maintains that

> In this vasomotor syndrome distress usually begins 10 to 14 days after operation it may date from the first solid food taken post surgically The syndrome is painless but disabling Symptoms begin suddenly during or ten minutes after eating and consist of profound nausea and weakness a generalized unpleasant sense of warmth cold sweating of the face (especially the forehead) and cardiac palpitation There may be hypermotility of the small bowel with excessive borborygmus ending in explosive diarrhea The attack usually lasting ten to sixty minutes may be prevented or relieved by the patient assuming a supine position

Diagnosis Roentgenographic examination with a barium meal will show the quick emptying of the stomach and the concurrent dilatation of the jejunum

One chain of symptoms appears shortly after ingestion of food while another occurs after a latent period of one hour or longer

Treatment Small and frequent feedings with calories derived from fat or protein may control the symptoms Surgical intervention is rarely required

Anastomotic Ulcer Gastrojejunostomy may be followed in about 5 per cent of examples by the development of an ulcer at the suture line (gastrojejunal) usually at the mesenteric border or in the efferent loop of the jejunum (jejunal) The transverse colon mesocolon omentum and pancreas become infiltrated and matted perforation into the colon results in a gastrocolic fistula

Errors of technic the use of unabsorbable sutures hyperacidity and susceptibility to ulceration are among the main causative factors

Symptoms The signs and symptoms usually manifest themselves about eighteen or twenty four months after operation Pain of a boring character is experienced below and to the left of the umbilicus It is usually severe and increases in intensity two or three hours after a meal Relief is obtained with the use of alkali Vomiting hematemesis and melena are not uncommon There is loss of weight tenderness rigidity and a mass is sometimes palpable in the area of the ulceration

Diagnosis A conclusive diagnosis is arrived at by the history signs and symptoms physical signs and roentgenographic examination Fractional test meals are revealing in showing high acidity

Complications Hemorrhage is extremely uncommon and perforation equally so

Treatment Surgery is indicated The anastomosis is freed from circumjacent structures If the original ulcer (usually at the distal end) has healed and the pylorus is patent resection of the affected loop of jejunum and adjoining part of the stomach should be effected (after separation of adhesions) and followed by closure of the opening in the stomach and end to end anastomosis of the jejunum As a rule the original ulcer is still present Resection of the jejunal loop should be accomplished with end to end union of the cut ends and incomplete gastrectomy (Polya s) Jejunostomy and repeated blood transfusions as a preliminary measure are of value in debilitated patients

Vagotomy has been found highly effective by many surgeons in the repair of gastro jejunal ulceration as a sequel of gastroenterostomy

In jejunal ulcer as a sequel to gastrectomy the treatment consists in

(1) Medical care

(2) Vagotomy, followed by proper dietary

(3) Substitution of retrocolic for antecolic anastomosis

Gastrojejunocolic Fistula Gastrojejunocolic fistula is often a sequel of gastro jejunal ulcer or of gastric cancer which has invaded the transverse colon or the splenic flexure It is one of the most serious complications of gastric surgery

There is a fistulous opening connecting the stomach, jejunum and colon thus allowing ingested food to pass directly from the stomach into the colon and in turn allowing fecal contamination of the stomach and small bowel This produces a severe diarrhea which leads to dehydration and anemia

The gastrojejunocolic fistula usually connects the jejunum with the transverse colon, rarely does the stomach connect directly with the colon The fistula is usually present close to the anastomosis and inferior to it and found in the distal loop of the jejunum

Symptoms The main symptom is diarrhea, which is influenced by the customary medical treatment

There is emaciation, weakness and dehydration, if the condition has been present for any length of time Eructation of gas of a stercorous odor is another of the more distressing symptoms Vomiting is present and is usually fecal in character (In the absence of intestinal obstruction fecal vomiting is pathognomonic of the gastro jeunocolic fistula)

Abdominal pain to the left and below the umbilicus may or may not be present

The prognosis is grave

Treatment The treatment is primarily surgical There have been many suggestions of technics to be followed in the cure of the fistula—from removing the anastomosis closing the wound in the colon the stomach and jejunum, and restoring the original continuity of the gastrointestinal tract—and some radical resections

Lahey and others advocate a technic whereby the terminal ileum is first cut, the distal end closed and the proximal end anastomosed to the descending colon as a first stage procedure At the end of two weeks the ascending colon the remaining terminal ileum the fistula the jejunum and the part of the stomach to be resected are removed en bloc and the end of the transverse colon distal to the fistula closed, with the fecal stream already diverted and established The jejunum is reunited by an end to end anastomosis and then anastomosed to the resected stomach

Late Strictures Narrowing at the site of esophago gastric anastomosis without evidence of recurrence of the tumor is sometimes noted

It is ameliorated by frequent dilatations

Diaphragmatic Hernia A loop of proximal jejunum sometimes herniates through the opening made in the diaphragm and into the pleural cavity The reconstructed diaphragmatic orifice may impinge on the jejunal loop the sutures remaining intact A diaphragmatic hernia may however occur owing to excessive negative pressure induced in the left pleural cavity in endeavors to remove air, concurrent with an increased positive pressure in the jejunum consequent on the removal of a jejunal

suction tube The dual effects may cause a loop of jejunum to thrust its way through the diaphragmatic hiatus When this loop is within the low pressure pleural space it expands and becomes completely obstructed or strangulated The obstruction progresses through the adjacent proximal loop (anastomotic) and this likewise becomes ballooned and in time there is rupture, not of the esophagojejunal anastomosis but of the entero anastomosis

Signs and Symptoms

(1) Epigastric distress (2) nausea (3) vomiting (4) hematemesis (5) early abdominal retraction (6) abdominal rigidity (7) symptoms of pressure on thoracic viscera, (8) dysfunction of the diaphragm inducing pain in the shoulder tip on deep breathing (9) dysphagia (10) palpitation (11) dyspnea especially when the patient lies down after a meal (12) hiccough (13) post prandial pain (14) anemia (15) anginal pain (pressure against the vagi reducing coronary blood flow)

Diagnosis The diagnosis of diaphragmatic hernia is almost wholly based upon roentgenographic examination

In the erect position fluid and gas levels may be noted

Roentgenographic examination is made in all positions

Differential Diagnosis The differentiation on occasion has to be made from (1) upward displacement of one or both domes of the diaphragm (2) subphrenic abscess, (3) subhepatic abscess (4) primary tumors of the diaphragm (5) paralysis of the diaphragm (6) spasm of the diaphragm (7) acute dilatation of the stomach, (8) hour glass stomach (9) diverticula of the stomach (10) gastric ulcer (11) cardiospasm (12) atelectasis (13) cholecystitis (14) aneurysm of the thoracic aorta (15) intestinal obstruction

Treatment In order to avoid such a contretemps it is best to induce complete re expansion of the lung by positive endotracheal pressure at the end of the operation

Routine bronchoscopy should be done after the operation to ensure patency of the bronchi to help prevent atelectasis thereby also diminishing the hazard of a high negative intrapleural pressure If the pneumothorax persists only a slight negative pressure should be maintained within the pleural cavity by aspiration under control of a pneumothorax manometer Expansion of the lung should be encouraged by active breathing exercises

The surgical approach may be along the abdominal route or from the thoracic one The first is by a left paramedian incision A stomach tube should be left in situ throughout the operation and the hernial contents withdrawn into the abdominal cavity The margins of the opening in the diaphragm are then drawn together

The transpleural route is sometimes preferable combined with crushing of the phrenic nerve to limit diaphragmatic movements thus facilitating repair of the hernia

Epigastric or other ventral hernias are not uncommon after gastric surgery as of other abdominal surgical procedures

Gallbladder Disturbances Disturbances of the gallbladder may occur following subtotal gastrectomy The changes at first appear to be motor ones, later there are biliary stasis and eventual gallstone formation with or without infection of the gallbladder walls

The mechanism of this biliary dyskinesia is most likely humoral (cholecystokinin) inactivity This is owing in part to diminished or absent hydrochloric acid in the

stomach which is a normal activator of this hormone in part to changes in the duodenal mucosa occasioned by relative inactivity of this part of the intestinal tract Other factors also play a part

Pancreatic Complication The injuries may result in an acute pancreatic necrosis or a purulent pancreatitis of diffuse or circumscribed nature Injury of major outlets may cause a post surgical pancreatic fistula

Symptoms The initial symptom is persistent epigastric pain under the left costal arch and sometimes in the left lumbar region The pain is dull and not exacerbated by movement or cough The sensation of indigestion is severe The patient is pale and slightly cyanotic Pulse and temperature may be normal and the blood pressure low There is more or less increase in the urine diastase As a rule the abdomen above the umbilicus is slightly dilated and on palpation some tenderness is found in the epigastrium and under the left costal arch

Treatment When the pancreas is injured in the course of an operation a tampon should be applied

Chronic Jejunitis This is an infrequent complication following gastrojejunostomy

Esophagitis This condition at times, is a late complication of gastroenterostomy

Looseness of Stools It is associated with steatorrhea, fat absorption sometimes being as low as 45 per cent The stools are loose pale and offensive Factors to be considered are (a) some neurogenic involvement of the pancreas and/or bowel affecting secretory or motor functions respectively and (b) alteration of flora or fauna of the upper bowel

Subphrenic Abscess This is usually a late complication The right side is more frequently affected and the abscess may be above the liver to one side or other of the falciform ligament or below (subhepatic) in the greater or lesser sac of the peritoneum Another variety is extra peritoneal In certain examples gas is present in the abscess variety

Anemia A high incidence of macrocytic hyperchromic anemia is present

A relation between gastric function and the formation of red blood cells is well known

In man total gastrectomy is often followed by a severe anemia There have been many reports in surgical literature of the development of true pernicious anemia following gastrectomy

Folic acid is beneficial in the treatment of macrocytic hyperchromic anemia

Herniation of the Lung This complication occurs along the lesser curvature to a position behind the stomach

Urinary Retention Urinary retention may be caused by (a) *prostatic enlargement* or inflammation abscess or stone (b) urethral stricture (c) lesions of the spinal cord (d) without demonstrable nervous disease (idiopathic), (e) *toxic* (f) *spasmodic*

Nervous System

Neurotic Vomiting Hysterical vomiting may be so severe as to be per se the cause of emaciation

Aerophagy This complication is purely one of the visceral conversion hysterical phenomena

Parotitis Parotitis is likely to supervene in aged persons who are debilitated and anemic Dryness of the mouth is a contributing cause

Many infections of this variety can be prevented by careful nursing and attention to the hygiene of the mouth

The onset usually occurs between the first and fifth post surgical days It is associated with fever, swelling over the gland and some degree of discomfort which is most severe on opening and closing the mouth

Pre and post surgical prophylaxis consists in hydration and as previously stressed oral hygiene and early start of active mastication

Roentgen therapy is often effective

Failure to Gain Weight This may be associated with inability to take so full meals as hitherto but it may also be occasioned by failure of fat absorption

Metastases This is an early complication Metastases to the liver occur relatively early The pleura may become secondarily involved by upward extension through the diaphragm

Metastases from carcinoma of the esophagus are widespread in the highly undifferentiated tumors the liver lungs and lymph nodes draining the area being most commonly involved

The first glands to become involved are in the pyloric area and lesser curvature Rectal examination very often confirms the diagnosis of metastases to the cul de sac of Douglas

The supraclavicular glands are involved later in the disease Secondary involvement occurs in the umbilical area and in the spine

CHAPTER XIII

Prognosis

The surgical results in gastric cancer depend mainly upon the stage reached when the diagnosis is made and the specific technic used The responsibility for early diagnosis is shared by patient and clinicians generally

The duration of the survival period depends upon

(a) Age of the patient
(b) Time factor of the symptoms
(c) Position extent and character of the growth
(d) Presence or absence of metastases
(e) Efficiency of the surgeon
(f) Choice of surgical technic

A study of the literature shows there is no agreement in regard to operability rate resection rate and the immediate result of surgery

It is known of course, that the five year survival rate in all examples of gastric cancer is low It is about 10 to 15 per cent Of patients who survive surgery about 50 per cent die of a recurrence within two years

Cancer taking root at the outlet of the stomach may cause symptoms of obstruction leading to early diagnosis and for this category the five year survival rate is higher—18 per cent

Balfour[180] showed that resection was possible in 43 16 per cent of his patients who were afflicted with gastric cancer and that five year "cures" can be obtained in 50 per cent of patients where the lymphatic glands are not involved (table 4)

Gatewood[181] in his series found the average length of life following exploration was 6 1 months after gastrojejunostomy 8 17 months, while the survival time was on an average four years and nine months

In 1942 Drs Walters and Berkson[18] undertook a study of 11,000 patients in which a diagnosis of malignant lesions of the stomach were made at the Mayo Clinic Of these 11 000 patients 6,357 underwent operations of which 2,840 were gastric resections In the great majority (99 per cent) of patients the lesion was carcinoma in only a small fraction (1 per cent) was lymphosarcoma or fibrosarcoma found The mean age of the patient was 55 years (fig 99)

More than 99 per cent of patients were traced postsurgically for more than five years

The survival rate for patients with resection were as follows five years or longer 28 9 per cent 10 years or longer 20 4 per cent 15 years or longer 15 2 per cent 20 years or longer 10 5 per cent 25 years or longer, 6 3 per cent

Harnett s[183] analysis of data collected by the Clinical Cancer Research Committee of the British Empire Cancer Campaign showed that of 1,405 patients with cancer

of the stomach treated in the hospitals of London during seventeen months in 1938 and 1939 only 56 or 4.03 per cent survived for five years Harnett found that resection before lymph nodes are involved gives a 60 to 63 per cent of normal expectation of life over a five year period of observation and 40 to 43 per cent if lymph nodes are involved at the time of operation whereas the average expectation of life for all patients (including those not treated) was 27.4 per cent of normal

TABLE 4—*Gastrectomy for Malignant Lesions of the Stomach 1948 and 1949*

Operation	Total malignant lesions		Carcinoma		Sarcoma	
	Patients	Hospital deaths per cent	Patients	Hospital death per cent	Patients	Hospital death per cent
1949						
Partial gastrectomy	148	5.4	144	5.6	4	—
Total gastrectomy	20	15.0	19	15.8	1	—
Total	168	6.5	163	6.7	5	—
1948						
Partial gastrectomy	174	6.9	166	7.2	8	—
Total gastrectomy	26	15.4	23	13.0	3	33.3
Total	200	8.0	189	7.9	11	9.1

(*Report on Surgery of the Stomach and Duodenum for 1949* Proceedings of the Staff Meetings of the Mayo Clinic Vol 25 No 20 Sept 27 1950 Drs Waltman Waters Howard K Gray James T Priestly John M Waugh)

In spite of this there is some evidence that results are improving The main factors contributing to this optimistic view are

1 Early surgery so that the operability rate is greater
2 Advances in pre and post surgical management
3 Advances in anesthesia
4 Radical surgery

Maimon and Palmer[154] wrote

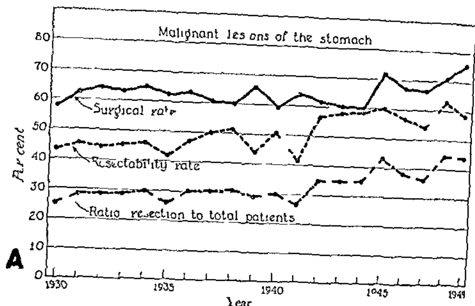
> Of 377 patients with gastric cancer 115 (30.8 per cent) survived resection 28 (7.4 per cent) of the 377 survived five years Eighty per cent of the five year survivors were restored to useful life

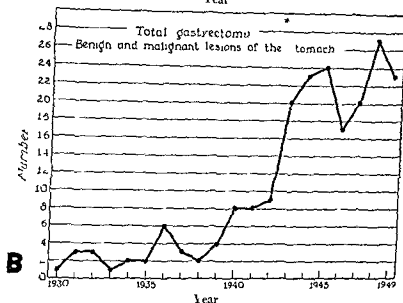
According to Moore State Hebbel and Treloar[155] the presence or absence of demonstrable metastases in regional nodes among patients subjected to gastric resection for carcinoma has a greater prognostic value than does the Borrmann variety of tumor

Pack and Livingston reported[1 1] that approximately 2 per cent of patients who have had cancer of the stomach are alive at the end of five years

These authorities[156] wrote

> If every patient with gastric cancer entered the best surgical clinic in the world 95 per cent would remain uncured and approximately 90 per cent would be dead of the disease in eighteen months





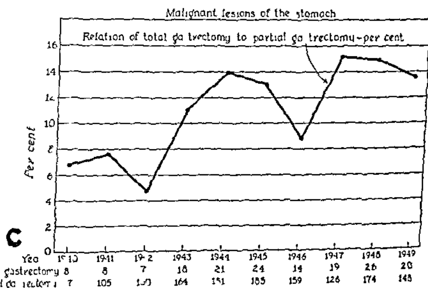


Fig 99—A Relation of surgical and resectability rates to the rate of resection *for total* patients given the diagnosis of malignant lesions of the stomach from 1930 through 1949 B Number of total gastrectomies in years 1930 through 1949 C A greater proportional increase in total gastrectomies to partial gastrectomies especially from 1943 (Courtesy Waltman Waters M D St Louis Mo Surgical Clinics of North America and W B Saunders Co)

Most gastric cancer patients are beyond the stage in which a cure may be hoped for before they are admitted to a hospital Some improvement in survival rates among resectable cases has been made since the time of Billroth but over all survival rates are still discouragingly small In the most favorable group of cases a five year survival rate of 50 per cent has

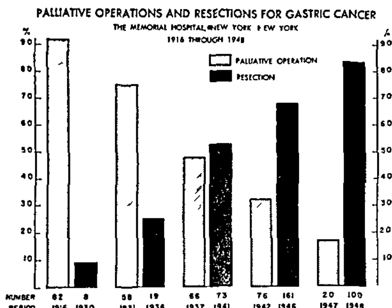


Fig 100—The changing proportion of palliative and curative operations for gastric cancer Memorial Hospital 1916 through 1948

TABLE 5—*Summary of 50 Cases of Carcinoma of Stomach*

Carcinomas	48
Lymphosarcomas	2
Metastases to Regional Lymph Nodes	32
Fixation to Contiguous Organs	11
Resectability	26
Operative Deaths (Pulmonary Emboli)	2
Palliative Procedures	14
Exploratory Laporatomy Only	10
Cause of Subsequent Deaths	
Metastases	26
Recurrences	24
Five Year Survival Rate	15%

Broder s grade 1 and 2 live longer than 3 and 4

In these cases the average age was 57 years the youngest was 29 while the oldest was 75 There were 38 males and 12 females

been attained yet the over all survival rate reported from most clinics is scarcely one tenth of that

In the first quarter century of effort at the Memorial Hospital for Cancer and Allied Diseases (N Y C) the curability of gastric cancer was only 3 to 4 per cent of all patients with the disease The histologic grade of the resected gastric cancer has a most decided

bearing on the number of five year definitive cures for example, Grade I 100 per cent Grade II, 41 7 per cent Grade III, 30 per cent Grade IV, 16 7 per cent (*See fig 100*)

Gordon McNeer *et al*[187] wrote that "the overall five year salvage in unselected patients with gastric cancer is still no greater than 10 per cent at most"

The conclusions arrived at by these authorities were

1 Subtotal gastrectomy for cure of cancer as commonly practiced in the past may have denied the chance for cure to about half the operative survivors because of the development of recurrence in the gastric remnant, duodenal stump perigastric lymph nodes, or stomach bed

2 To lessen the possibility of failure in the future two alternative courses seem indicated (a) standardization of the procedure of radical subtotal gastrectomy for cancer or (b) routine employment of *total gastrectomy* for *all* operable gastric cancers by experienced surgeons

3 Total gastrectomy would seem the most logical operation for the treatment of gastric cancer in the light of the findings

Table 5 (above) contains a summary as to age sex, operative mortality and duration of life after surgery in 50 cases treated by the author

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